INDEXED

# Marine Engineering

DECEMBER, 1905.

## THE NEW HAMBURG-AMERICAN LINER AMERIKA.

On October 20 the latest and most luxurious of the enormous intermediate steamers which have recently been put into service on the North Atlantic made her first appearance in New York harbor. This ship, which is with a single exception the largest in commission, was partly described at page 276 in our issue of July last, on the occasion of her launching. The main dimensions, which we will repeat from that description, show that she has a length of 670 feet between perpendiculars, 686 feet over all; a beam of 74 feet and depth of 52 feet; the height to the boat deck is 77 feet 6 inches, the displacement, 40,000 tons, and the cargo carrying capacity, 15,000 tons. The gross tonnage is given as 22,724. The ship is propelled by twin screws, actuated by quadruple expansion engines balanced on the Yarrow-Schlick-Tweedy system, and the balancing is said to be so good that scarcely a tremor is felt in any part of the ship due to the action of the reciprocating parts of the engine. The indicated horsepower is a little over 15,000, which corresponds with a sea speed of about 17.5 knots. On her maiden voyage, the *Amerika* covered the distance from Cherbourg to Sandy Hook, 3,050 nautical miles, in seven days, seventeen hours and twelve minutes, this being at the average rate of 16.45 knots.

THE AMERIKA STARTING FOR EUROPE, OCTOBER 26, 1905.

(Photograph, Byron, New York.)

Accommodations are provided for 550 first class, 300 second class, 250 intermediate or third class and 2,300 steerage passengers, which, with the crew of 600 men, makes a total of 4,000 persons on board when all the accommodations are taken. The first class apartments are luxurious in the extreme, and beautifully decorated. A number of imperial suites at the forward end of the lower promenade deck include three to six rooms each, having appointments very similar to what is found in first class hotels. In addition to this feature some of the rooms are of unusual size for shipboard, the largest being 12 by 14 feet in measurement. Other high class accommodations on the upper and lower promenade decks include suites consisting of sitting room, bed room and bath room, the decorations of no two of which are the same, some being in the Empire style, others in that of Louis XVI, etc. It is noteworthy that in no case does any first class state room have an upper berth, and in a great many cases, the lower berths are arranged somewhat in the manner of the berths on Pullman sleeping cars, so that they may be transformed for daylight use into luxurious settees.

Another innovation on this ship, which has already proved a success, and which is bound to be popular with a great many people, is the à la carte restaurant, situated upon the upper promenade deck, which is operated by the proprietor of the Ritz hotel in Paris and the Carlton hotel in London. Passage on the ship may be engaged with or without meals, the latter contingency providing for the use of the restaurant. The accommodation in this apartment is for 120 persons, the idea being an elaboration of the grill room feature on the *Deutschland* of the same line. The restaurant is decorated in the renaissance style with elaborate fittings in chased bronze. The walls are paneled in mahogany and chestnut, mounted in bronze after the style of the eighteenth century. In place of the usual circular port holes are fitted large square windows, while a skylight of artistically stained glass and framed in wrought iron makes the apartment very light throughout the day. At night a soft light is diffused from large crystal electroliers and

beautiful ormolu wall brackets. The arrangement of the tables is such that parties of from two to eight will be accommodated at the several tables, while one special table will seat twelve. The chairs are copies of an old Versailles design, with a pattern of tapestry used by Marie Antoinette in the Petit Trianon.

In addition to the à la carte service table d'hôte service will be provided in the main dining saloon, which is on the saloon deck and extends through the full width of the ship for a distance fore-and-aft of 100 feet. This saloon will accommodate nearly 400 people. The walls are pearl gray, hung with copies of Bouché's productions, with carpets and table coverings of old gold. The furnishings are of the Louis XVI period, with

THE SOCIAL HALL AND MUSIC ROOM.

(Photograph, Byron, New York.)

wood carvings reproduced from those in the Grand Trianon.

Other novelties on this ship not usually found on even the largest and latest of the Atlantic liners are the passenger elevator running through five decks; the flower shop on the Roosevelt deck; the candy shop; an unusually complete gymnasium; telephones connecting all staterooms with a central station; an elaborate nursery for the children; electric and hydropathic baths,

THE DOUBLE-DECKED SMOKING ROOM.

(Photograph, Byron, New York.)

THE WRITING ROOM.

and a staff of trained nurses for the use of such passengers as may have occasion to require their services. It might be mentioned at this point that the several accommodation decks in the steamer have been given distinctive names instead of the usual nomenclature employed in such cases. The names, counting from the uppermost downward, are Kaiser, Washington, Roosevelt, Cleveland and Franklin.

THE RITZ-CARLTON CAFÉ, ON KAISER DECK.
(Photograph, Byron, New York.)

One of the most striking features on this ship is the first class smoking room, which has the unusual distinction of running through two decks. Our illustration gives a splendid idea of the general appearance of this room, the upper deck being, as shown, in the form of a broad gallery with an open space in the center, allowing light from the skylight to illuminate both decks. The apartment represents as nearly as possible a great hall or hunting room of an Elizabethan manor house, with solid oak hand-carved and purposely left with the wrought tool marks, to carry out more fully the desired effect. There is a

THE BROAD SWEEP OF THE BRIDGE DECK.
(Photograph, Byron, New York.)

THE MAIN ENTRANCE, STAIRWAY AND FLOWER SHOP.
(Photograph, Byron, New York.)

huge Elizabethan fireplace with a stone hearth. The upholstery in this apartment is as usual very plain and of leather, it being the purpose to retain no more of the odor of tobacco than can be helped. The artificial lights consist in incandescent lamps mounted in conventional ships' lights; and the effect is very pleasing.

At the after end of the Kaiser deck is the ladies' cabin, social hall and music room, which is a very spacious apartment, beautifully decorated, and lighted by large square windows and an octagonal skylight let into the center of the ceiling. An open fireplace on the after side of this room is one of the features, while directly opposite it is a full length life-size painting of Emperor William II. Four bookcases contain the larger part of the passengers' library. Just forward of this room on the starboard side is the writing room, which is very tastefully fitted up and contains a number of paintings. The staircases throughout the first cabin apartments are most elaborate and have very easy ascents. The metal balustrades are very tastefully designed, and in some cases where the stairway is broad an auxiliary balustrade is carried down the center. One of our illustrations shows this effect, as well as the great size of the main entrance hall for first cabin passengers, while in the background of the same view is seen the flower shop above mentioned. The promenade space has been very carefully worked out, and in many parts of the ship are found large areas for steamer chairs, and in some cases areas sufficiently large to be used for dancing.

The equipment of the ship includes, besides the above mentioned features, a number of others now seen in all the latest first class ships, such as Marconi wireless telegraph system, a splendid system of ventilation by means of which the air in all the rooms is completely changed at very short intervals of time, submarine bell signals to give warning of approaching dangers, a large number of transverse bulkheads with the

THE AMERIKA AT SEA.

THE STAIRWAY FROM KAISER TO BRIDGE DECK.

Stone-Lloyd system of watertight doors, the doors being automatically closed from the bridge by means of a single handle, the Dayton automatic fire extinguisher apparatus, filtering apparatus and a system of hot and cold fresh water supply throughout the ship.

THE NURSERY.

The ship, as a whole, reflects great credit upon her builders, Harland & Wolff, of Belfast; upon her decorators, and upon her owners.

THE MANXMAN AT 23 KNOTS.

## RECENT TURBINE STEAMERS.

Great activity has been evident during the past two years in the construction of turbine steamers, and from recent tests made there seems to be every reason to believe that turbine-driven vessels will be extensively used in the future.

### THE MANXMAN.

One of the accompanying illustrations shows the triple-screw steamer *Manxman*, which is equipped with Parsons steam turbines, and has made a speed of over 23 knots. She was constructed by Vickers Sons & Maxim, Ltd., at Barrow-in-Furness, and has a total length of 330 feet on the water-line, a depth of 25½ feet with four decks, and a molded breadth of 43 feet. She is provided with three sets of turbines, consisting of a high-pressure turbine operating the center shaft, and two low-pressure turbines driving the two side shafts and propellers, the latter being also connected to two astern-driving turbines which take the steam direct from the boilers. In an official trial of six hours, with the low-pressure turbines operating at 590 and the high-pressure turbine at 520 revolutions per minute, a mean speed of 22.65 knots was obtained, the vacuum being 28.5 inches. Since the official test, trials have been made showing a mean speed of 23.141 knots with a boiler pressure of 192 pounds, the pressure at the center turbine being 180 pounds and at the two low-pressure turbines 20 pounds per square inch; the speed of the latter was 609 and of the former 533 revolutions per minute.

The *Manxman* is heated by the thermo-tank system installed by the Thermo Ventilating Company, of Glasgow, Scotland, which is said to have given excellent satisfaction, producing the required heat in fifteen minutes with an exceptionally small consumption of steam, while tests have shown, it is stated, that three hours would be required to attain the same temperature by the ordinary steam-heating system. The steamer was constructed for the Midland Railway Company's steamship service for the Isle of Man traffic, which requires large saloons and promenade spaces. The shade deck is used exclusively as a promenade, and the promenade deck is especially designed with wide spaces on each side for use in a similar manner. The dining room, which takes the full width of the vessel, has a capacity for seating 100 passengers.

The boiler equipment includes one single-ended boiler 11 feet 6 inches long and 15 feet 7 inches in diameter, and two double-ended boilers 22 feet long and of the same diameter, the former having three furnaces and the latter six furnaces, with heating surfaces of 2,493 and 4,984 square feet respectively. The single-ended boiler has 80 square feet of grate area, and the double-ended boilers 161 square feet each; the total grate area being 402 square feet, and the total heating surface 12,461 square feet.

### KING EDWARD'S NEW STEAM YACHT.

The new steam yacht for King Edward VII is being built by Messrs. A. & J. Inglis, Glasgow, who received the order in competition with a number of shipbuilders. Messrs. Inglis submitted a model showing the form of the hull and the general appearance of the vessel, and a drawing showing the yacht at sea. The various tenderers were invited to submit designs, and were left very much to their own discretion in the planning of the vessel, except that they were informed of the general dimensions and the draft required. The yacht is to be considerably smaller than the *Victoria and Albert*, and of a draft sufficiently light to enter ports into which the larger vessel cannot go, such as Flushing and Nice. She is to be fitted up for the royal family and their private suite, and not for large parties of guests, and it was stipulated that she was to have turbine machinery.

Messrs. Inglis' design was picked out very early as especially suitable, and when submitted to the king met with his approval. They proposed to build a vessel 285 feet in length on the load

water-line, 40 feet in breadth, of 2,000 tons gross, propelled by three Parsons turbines driving separate shafts, with one propeller on each shaft, and having a speed of 17 knots. They also submitted designs for the internal arrangements of the vessel. The new yacht will replace the *Osborne,* and will be 137 feet shorter than the *Victoria and Albert,* and of less than half the tonnage.

THE OSTEND-DOVER STEAMER PRINCESSE ELISABETH.

The fleet of the Ostend-Dover line is composed of nine large steamers having trial speeds ranging from 19 to 22 knots. The older and slower ships are being constantly replaced by faster ones. The latest addition is the turbine steamer *Princesse Elisabeth,* which was put in service at the beginning of October. The arrangements for luxury and comfort of the travelers on this steamer surpass the best that has been provided heretofore for this type of ship.

STEAMER PRINCESSE ELISABETH AT FULL SPEED.

The *Elisabeth* has a length over all of 357 feet, a beam of 40 feet, a depth to promenade deck of 23 feet, and to bridge deck of 30 feet. The machinery is composed of three compound steam turbines of the Parsons type, each operating a single screw. One of the turbines receives high-pressure steam and the other two low-pressure, the total power developed being about 10,000 horsepower. There are turbines likewise provided for running backwards. The propellers are of bronze cast in a single piece. There are eight cylindrical tubular boilers arranged in two groups of four each with two transverse fire rooms. The boilers are operated at a pressure of 150 pounds per square inch, and use forced draft on the Howden system.

The hull was constructed of mild steel and contains a lower deck, second deck, upper deck, promenade deck, and bridge deck. The bridge deck, which serves as a shelter for the upper deck, is accessible to first-class passengers for promenade purposes. This deck has, besides the pilot house, the captain's cabin and the Marconi wireless station, and lifeboats six in number, and two small boats. These boats are all launched by means of special Welin quadrant davits, which permit rapid action, due to the fact that a movement of oscillation is employed instead of one of rotation.

The upper or promenade deck is occupied for nearly two-thirds of the length by a steel deck house, containing from forward to aft respectively the smoking room, the ladies' parlor, the companionway to the dining hall and first-class accommodations, twenty first-class state rooms, two state rooms de luxe, and a royal saloon, without mentioning the two funnels and casings. The forward end of this deck is occupied by the anchor gear with capstan and the aft end by a steering engine and capstan.

The second deck shelters the large restaurant, seating 120 people, the galley and lavatories of the first-class passengers. At the rear, besides engine and boiler spaces, are quarters for stokers, the state rooms for the principal officers, together with store rooms and stairway leading to the second-class apartments. The lower deck has at the forward end quarters for sixteen stewards and cooks, various quarters for first-class and second-class passengers, and at the rear a second-class smoking room with buffet, second-class ladies' parlor, and crew's quarters.

The total equipment provides for the carrying, besides the crew of seventy persons, of about a thousand passengers. All these saloons are fitted up very comfortably and those of the first-class very luxuriously. The decoration of the first-class dining saloon includes twelve allegorical panels painted on linen and representing the twelve months. The ceiling is of wood decorated and painted in imitation of antique bronze. It is subdivided into panels where the electric lights to the number of thirty are let down. The floor is covered by Brussels carpet.

The smoking room, which is so placed as to give the passengers a good view of the sea, is treated very severely but comfortably. The walls are of Hungarian oak polished in natural color. The companionways and stairs giving access to the first-class apartments are decorated likewise quite severely in wood, with inlaid floors, and passageways lined with linoleum. All of the quarters are splendidly heated and ventilated, the heating being by steam on the system known as "thermo-tank." This system consists of two pieces of apparatus situated upon the bridge, each composed of a steam heater and a ventilating fan operated by an electric motor, and permits the withdrawing of vitiated air and supplying of fresh air to each apartment. The air is distributed by means of pipes running along the ceilings and walls.

The electric installation on board consists of two generators, of which one is used to supply current to the motors operating ventilators and to the small fans in the saloons. The second serves for supplying current to a powerful searchlight and for all lights on the ship. The latter number more than 300 incandescent lamps. The two generators are identical and interchangeable and each is operated by a small direct-connected steam turbine. Telephonic connection is maintained between pilot house and the engine room, while the wireless telegraph apparatus already mentioned is taken care of by means of power from one of the generators, the receiving wires being strung from the masts

THE MAHENO MAKING 17.5 KNOTS ON TRIAL.

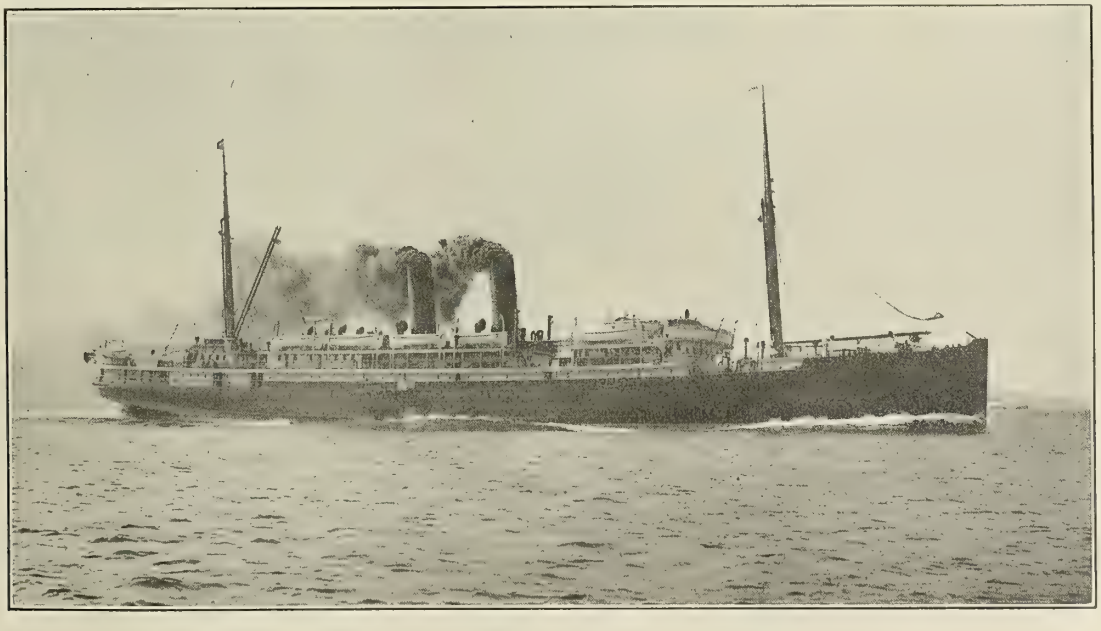
The *Elisabeth* has shown herself to be the fastest of all the boats in service between England and the Continent, for she has attained a speed of 24 knots during a trial trip of four hours, this being 1½ knots greater than the speed guaranteed by contract. The speed attained in a rearward direction reached 16 knots in place of the guaranteed 13. The nautical qualities shown by the ship on trial trip and since in service have given perfect satisfaction, particularly the facility with which she answers the helm. The vibrations are so insignificant that it is difficult to tell when within the ship whether she is moving or not.

### A TURBINE STEAMER FOR THE PACIFIC.

William Denny & Brothers, Dumbarton, Scotland, have constructed for the Union Steamship Company, of New Zealand, a new triple-screw turbine vessel named *Maheno,* of which we present two photographs, taken on her trial trip at the end of September. This vessel is intended for the inter-colonial trade, as well as for the long run between New Zealand and Vancouver, B. C. The dimensions are 400 feet by 50 feet by 38 feet 6 inches deep, and she was built to the rules and under the special survey of the British Corporation. The entire main deck, together with a large central house on the upper deck, is devoted to the accommodation of passengers, of whom about 225 first-class and 120 second class will be carried. There is also provision for about sixty third-class passengers when the vessel is on the Vancouver run.

The first-class passenger accommodation is in the midship portion of the vessel, and is mostly in three-berth rooms, which are fitted with special conveniences devised by the company from their long experience in this trade. The dining saloon, at the fore end of the midship deck house, is framed in fumed oak, with ground treated in reeded oak, stained green. Two long tables provide dining accommodation for the majority of the passengers, and a number of small tables are located at the sides. There is an organ at the fore end of the saloon, and large sideboards at the after end, framed in harmony with the general design. The saloon is lighted at the front and sides by large rectangular brass-framed windows, and also by a dome above. Ventilation is secured by large flail fans on the ceiling. The upholstery is in green and gold moquette, and the floor is laid with red Wilton carpet.

The music room, on the deck above, is of Adams design in white

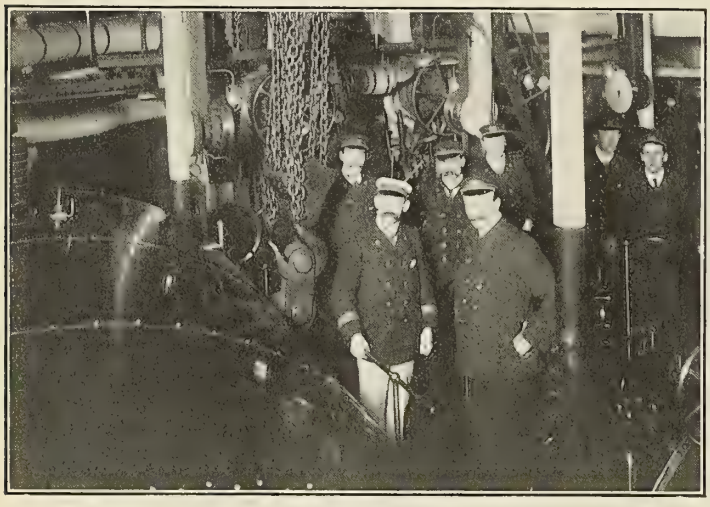


THE PACIFIC STEAMER MAHENO AT FULL SPEED.

enamel with gold silk panels. The ceiling, which is flush with the under side of the beams, is in Tynecastle tapestry. A central ottoman is fitted round the dome to the dining saloon, and there are a number of cosy corners luxuriously upholstered, and artistically screened from the rest of the room. The piano is a Bechstein grand, in dark mahogany to match the rest of the furniture. A feature of this apartment is the leaded glass, which together with the rest of the decorative work of the vessel has been entirely carried out in the builders' yard.

The smoking room, situated on the shade deck, forward of the turbine hatch, is framed in Burmese padouk, a simple classic design being adopted to display the rich figure of this wood. There is a high dome above the smoking room lined in anaglypta, with a tier of clerestory lights in stained glass. The frieze represents ancient war galleys, in relief. The main vestibules are framed in walnut with satinwood panels. Large oval mirrors are worked into the design with richly carved spandrils.

The accommodation provided for second-class passengers is of less elaborate design, but is very little short of the first-class in the matter of comfort and convenience.



ENGINE ROOM OF ALLAN LINER VICTORIAN.
(Photograph, Richards, Montreal.)

The *Maheno* is lighted throughout by electricity, for which there is duplicate plant. A refrigerating installation on the ammonia system is fitted both for cargo and for ship's use. The cargo gear consists of hydraulic hoists, working double derricks at each hatchway. The steering is effected by means of a steam tiller aft, controlled from the flying bridge by telemotor. A powerful windlass with warping ends and a warping winch in the wheel house aft enables the vessel to be expeditiously moored in harbor. The fire-extinguishing appliances consist of a fire system of galvanized pipe and hose, kept in glass-fronted lockers at various stations throughout the vessel. In addition to this, the Clayton system of fire extinguishing by means of sulphur dioxide is installed, and provision is made for fire extinguishing by steam.

The vessel is propelled by a set of Parsons patent turbines, constructed by Messrs. Denny & Co. There are three turbines, one high and two low-pressure, working three shafts, with three propellers in all. The go-astern turbines are contained within the low-pressure, and work on the wing shafts. The reversing gear is particularly well arranged, the whole of the engines being easily controlled by one engineer. Steam is supplied by four cylindrical tubular boilers, two double ended and two single, at a working pressure of 150 pounds per square inch, and fitted with Howden's system of forced draught. The auxiliary machinery is very complete, and consists of air and circulating pumps to each main condenser, each set consisting of two Edwards air pumps and one centrifugal pump, driven by simple two-cylinder engines; two of Weir's feed pumps, auxiliary condenser with necessary pumps, two large duplex pumps for bilge and ballast purposes, a Caird & Raynor distiller, and a vertical duplex wash deck and fire engine, suitable for working See's ash ejector, sanitary pump, steward's pump, water-service pump, oil pumps, etc. The mean speed for six hours was 16.4 knots, with two-thirds of the boiler power only.

## MOTOR BOATS, VI.

BY DR. WILLIAM F. DURAND.

### THE BOAT.

The general problem of the motor boat has been already stated in the first of the present series of articles. Since this introductory development of the problem, as a whole, we have been concerned with the second of the three main divisions, the problem of the motive power.

We are to turn now to the first division as previously classified, the problem of the boat as to form and structure.

The problem thus approached naturally divides into two parts:

(1) The selection of such proportions and such form of hull, having due regard to carrying capacity, comfort, seaworthiness, etc., as shall insure the minimum resistance at the designed speed, and thus permit of realizing such speed with the minimum power, or the maximum speed with a given power.

(2) With given form and dimensions and with due regard for strength, to construct the boat with the minimum weight of structural material, thus allowing the maximum share of the total displacement for carrying capacity and for machinery.

Taking all conditions at the extreme limit it follows that the motor boat of the highest attainable speed will show, on given dimensions, the lightest construction of boat consistent with the needed strength, a form suited to the highest speeds within the range of hope, and the maximum power developed on the fraction of displacement allotted to this purpose. For more moderate cases the boat may be made stiffer and stronger, fuller in form and with higher freeboard, giving greater roominess and carrying capacity (all conducing toward seaworthiness and general safety), combined with a generally heavier style of machinery construction conducing toward longer life and decreased expense for maintenance. These various desirable features are of course realized at the expense of some reduction in speed, and the result becomes a general compromise, as, in fact, all examples of engineering design of necessity are.

We shall postpone to a later point the discussion of structural features, and shall now proceed to a consideration of the factors which enter into (1) as above specified—the determination of such forms and proportions as will conduce to minimum resistance with an acceptable combination of other elements.

*Resistance.*—The resistance of any boat-formed body moving through the water may conveniently be divided into two parts:

(1) The skin effect or so-called skin friction. This part of the resistance depends primarily on the extent and character of the wetted surface of the boat and on the speed, and increases a little more slowly than with the square of the speed.

(2) The wave effect or part which is manifested as surface disturbance. This part of the resistance depends chiefly on form, proportion and speed, and varies with the speed by an index which lies usually between 3 and 4.

At low speeds the larger part of the resistance falls under class (1), and if low speeds alone were required, the form and proportions adopted would be such as to give a small wetted surface relative to the size of the boat. This would result in a relatively short, broad, deep model, rounded in form somewhat like an elongated hemisphere, and with a boat-formed bow and stern. As the speed advances, however, the wave-making resistance becomes more and more predominant, and at high speeds it takes first place, forming more than one-half the total resistance. If in some extreme case wave making could be imagined as the only form of resistance, the ideal boat form would be then reduced as nearly as possible to the proportions of a vertical plane. Such a boat would show an excessively narrow beam for

the length, with knife-edge bow and stern. Actually, however, skin resistance is always present, and in any case a compromise is effected in accordance with the special circumstances in hand. Thus for moderate speeds a fairly large proportion of beam to length is permissible, with form moderately well filled out at bow and stern. As the demand for speed increases so must the proportion of length to beam increase, and coupled with increasing fineness of form at bow and stern, worked out in accordance with considerations to be discussed at a later point.

tinuously with increase in designed speed, and only for the lowest speeds can the lower values of this ratio be considered acceptable. Thus in the practice of the day actual values of this ratio are found between 5 and 10. The latter represents about the extreme value practicable under existing conditions regarding strength and space required for machinery. There is good reason to believe that still narrower boats would show excellent results at high speeds so far as considerations of resistance are concerned, but strength and room for machinery are obtained with continuously

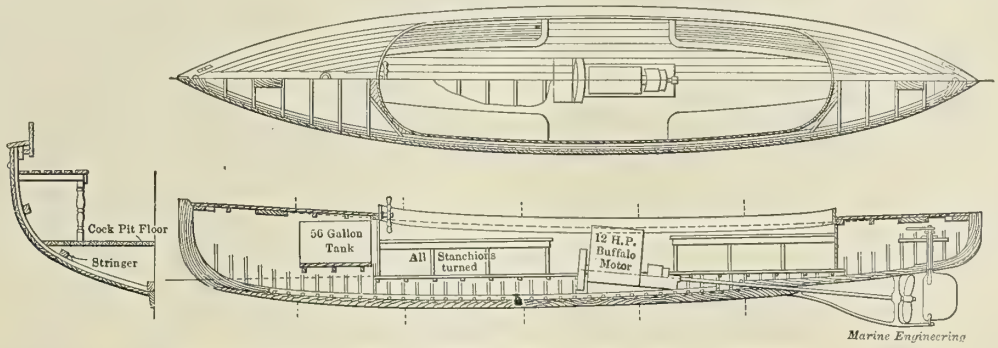



FIG. 33.—INBOARD PROFILE, SECTION, AND PLAN OF A SMALL MOTOR BOAT.

The actual proportions and form of a boat must, however, to some extent be determined in recognition of the internal space required for the proper installation of the machinery, while qualities relating to safety, seaworthiness, etc., demand likewise some recognition in the final combination. In particular, considerations of this character usually force the selection of a greater breadth of beam or greater proportion of beam to draft and length than would be otherwise selected for the higher range of speeds.

It may be well to note at this point that while the terms high speed and low speed are arbitrary in themselves, there are general limits in the relation of speed to length above and below which the terms high and low may fairly be applied. Roughly speaking, this limit measured in knots is close about the square root of the length in feet, higher as the beam is narrower and form is finer, and lower in the inverse cases. Thus for a boat 25 feet long any speed above 5 to 6 knots will be high in the sense that wave-making resistance will be of some considerable importance, and the entire design of the form of the boat must be carried out with this fact in view. Likewise, for a larger craft 60 feet in length, speeds much above 8 knots or, perhaps, from 10 miles per hour upward, will produce such surface disturbance as to demand recognition in the design of form. From these

increasing difficulty as the beam is decreased in proportion to the length. Thus a boat 4 feet beam and 50 feet in length would doubtless show excellent results, so far as resistance is concerned, when pushed to speeds of 20 miles per hour or above, but such proportions would tend to render the boat flexible and, perhaps, unsafe in a seaway, and such beam would give quite insufficient width for the proper installation of the machinery suited to the development of the speed. In short, if the high speeds at which it is proposed to drive the boat might justify some such proportion of length to beam so far as resistance is concerned, the fact remains that the space demands of the machinery required to realize the speeds will not permit it. It thus results that ratios of 9 to 1 or 10 to 1 represent about the upper practicable limit under present conditions of engineering practice.

From these upper extremes we come down through all gradations to lower limits of 4½ to 1 or 5 to 1, found only in very short boats or in longer boats designed for low speeds, and which are intended to be roomy and large in carrying capacity or in which stiffness and safety in a seaway are of special importance. The general class of moderate-sized boats intended for fair speed, and with some consideration paid to matters of capacity and general comfort, show a length of 5½ to 6 or 7 beams. Lengths

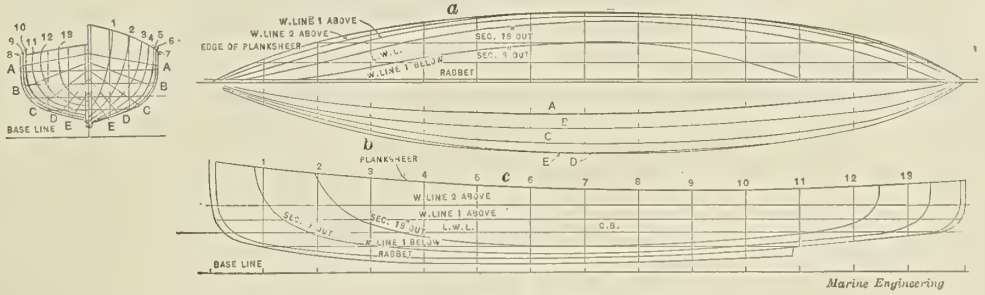



FIG. 34.—LINES AND BODY PLAN OF A SMALL MOTOR BOAT.

proportions it is easily seen that practically all motor boats are run at speeds which are high in the sense in which the term is here used. Few boats are less than 16 or 18 feet in length, and for the average small boat up to 40 or 50 feet in length speeds of 7 to 9 or 10 miles per hour are considered the minimum acceptable.

Referring again to the relation of length to beam, it is clear from what has been said above that so far as resistance alone is concerned the ratio of length to beam should increase con-

in excess of the higher figures indicate some special attention to high speed, and with other qualities sacrificed in some measure as the price to be paid for its attainment.

The proportion of beam to draft is of less relative importance, so far as resistance is concerned, than that of beam to length. Generally speaking, reduction in beam may go hand in hand with increase in draft, and thus the narrow, deep model forms a natural combination as well as its opposite, a broad, shallow form. For the usual type of motor boat it will be safe to select

what may seem to be a suitable proportion of length to beam, and then allow the draft to be determined by the resultant weight conditions of the boat.

We may now turn to the question of the form of the boat, first for the underwater body and second for the part above the water-line. Naturally the characteristics of form will depend much upon the various other special requirements of the case, and especially upon that of speed. We may, therefore, with advantage take for first consideration boats of the highest speed and note the characteristics of form which tend toward its most effective realization. Naturally, furthermore, this is by no means a matter in which all opinions are in accord. Differences in both theory and practice exist among the best designers and builders growing out of different views regarding the relation of the various elements going to make up boat resistance, and out of differences in experience in connection with problems of actual design. The following suggestions, however, contain the points generally agreed upon, and represent the general consensus of view regarding the best combination of form characteristics suited to the development of high speeds.

Forms showing a short, vertical cutwater with well rounded forefoot and keel line, gradually sloping thence down to full draft at a point farther aft, cannot be recommended. Length on the water-line is always of importance, and with any such form of cutwater and forefoot there will be a serious loss of effective length of water-line, especially at high speeds or under any condition which may involve a lifting of the bow somewhat above its normal trim. It is of small use to build a boat 40 feet on the water-line if at the highest speeds the bow may rise and shorten the effective length to 35 or even 30 feet. This fault has been noted in some cases of recent so-called "auto-boat" design, and it is one to which designers may well pay special attention.

For the after body the popular torpedo boat model shows for the immersed part of the boat a gradually tapering wedge with edge at the stern, horizontal in line and at the surface of the water. That is, assuming the upper part of the boat cut off by a plane at the water surface, the remaining part would show such a wedge-shaped form, its base joined to the forebody, and with its lower surface sloping easily upward to the horizontal edge at the stern, and lying at the surface of the water. The

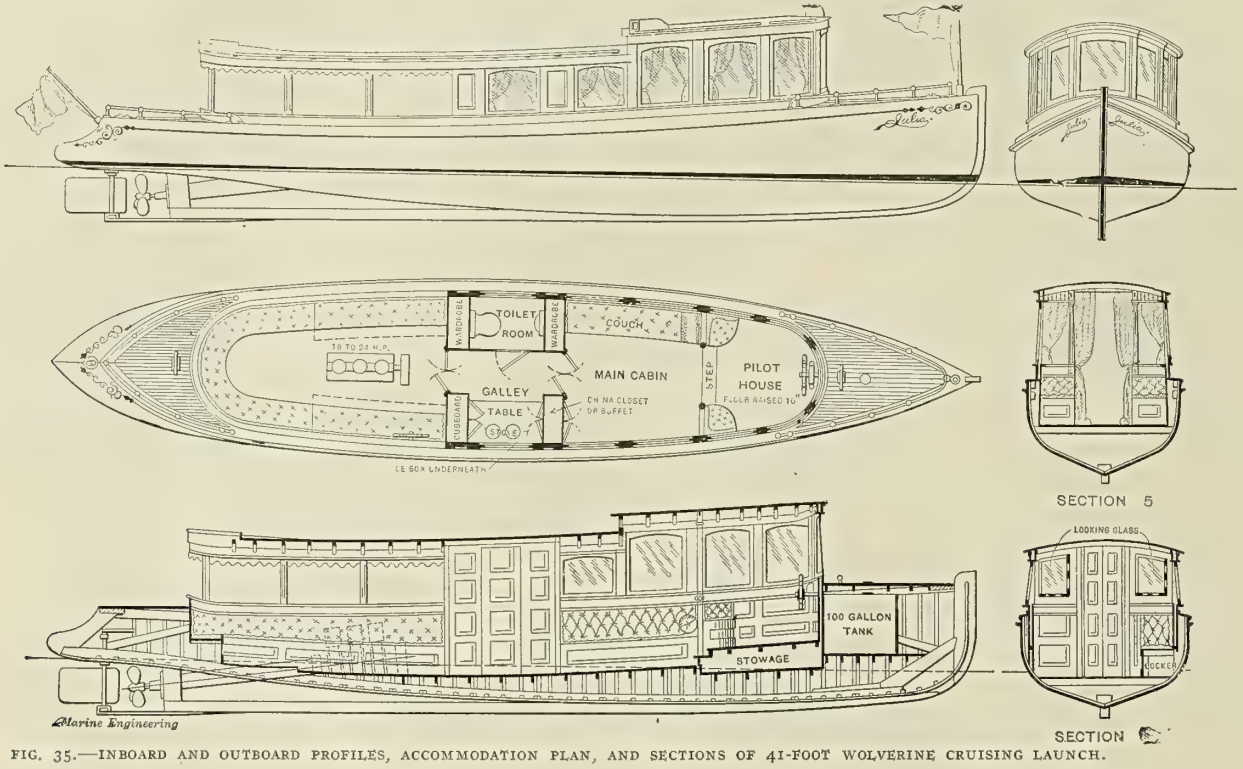



FIG. 35.—INBOARD AND OUTBOARD PROFILES, ACCOMMODATION PLAN, AND SECTIONS OF 41-FOOT WOLVERINE CRUISING LAUNCH.

At the bow the underwater form should represent a gently tapering wedge with edge vertical and cutwater sharp. The angle of the wedge will be determined largely by the length to beam ratio. Whatever this ratio may be, however, the angle of entrance should be made as easy as the conditions will permit, advantage being taken, in most cases of high speed design, of the flat stern to which reference will be made at a later point, and which permits the maximum beam to be carried much farther aft than would otherwise be the case, thus insuring finer angles of entrance than with maximum beam amidships. Regarding the form of sections at the bow, both *U* and *V* shapes are used, but the former may fairly claim the preference, especially as regards wave-making resistance. The lifting effect at the bow is also less pronounced, and there is less disturbance to the trim at high speeds with *U* than with *V* sections. A certain amount of bodily lifting of the boat at the highest speeds with the consequent reduction in wetted surface and in resistance is, of course, to be desired. This may, however, be better determined by a suitable adjustment of the form somewhat farther aft, and the lifting effect thus located will produce but slight change in the trim at operating speeds.

older form of after body is in general character similar to that of the forebody, but with pronounced *V* or flaring sections near the stern, thus permitting a better run of water to the propeller, and presenting less resistance to propulsion than would result with a duplication of the form at the bow.

Comparing these two forms of stern, the following points may be noted as constituting the chief claims of the torpedo boat form for special consideration.

(1) It permits the greatest beam to be located well aft of amidships, thus insuring finer water-line or entrance angles at the bow.

(2) It places the surface of the boat at the stern in the best possible position to find support from the water pressures in that locality, such upward pressures effectively resisting the tendency to settle at the stern so commonly shown by small boats at high speeds, and which may so seriously disturb their running trim.

(3) The entire absence of deadwood places the propeller still more satisfactorily in the direct run of water under the stern, and thus contributes to its effective operation as an instrument of propulsion.

(4) On the same over-all dimensions it gives more water

plane area than the common ship-shaped form, and thus more stiffness against heeling, more stability, and more safety so far as the latter may depend on these characteristics.

(5) For the same reason as in (4) the part of the boat above water may be made more roomy at the stern, thus adding to the comfort and general serviceability of the boat.

On the other hand the following two points must be set as disadvantages over against the preceding desirable qualities:

(1) The large amount of nearly flat, horizontal surface at the stern tends to render the boat uneasy in a seaway, and may result in severe pounding. It is, in fact, generally agreed that for service in rough weather this form of stern is somewhat inferior to the older or ship-shaped model.

(2) The absence of deadwood places the propeller as it were out in the open, and thus exposed to damage from floating drift or in case of grounding.

Mention may be made at this point of the possibility of so adjusting a stern overhang that the water-line length when the boat is at rest shall be considerably less than when under way. The rating of boats for regatta purposes naturally includes the water-line length as an important factor, and such a form of design may result in the location of a boat in a lower rate than that in which she might belong if measured when running at a high rate of speed. An overhang carrying out the general form of the stern and located just clear of the water when at rest will be brought down by a small change of trim due to slight settling at the stern, and will thus form a part of the effective length of the boat. This is a matter primarily of jockeying, and has no relation to the scientific basis of boat design. The length for rating should in fact be determined on the water-line when running at top speed, and with such method of measurement there would be no further temptation to resort to such methods of gaining an advantage in measurement rating.

Quite aside from the question of rating the form at the stern should be so adjusted with reference to the weight schedule and to a suitable location of the machinery and other weights, that at top speed the lower knuckle or under surface of the boat at the stern will nicely settle to the surface of the water, and without tendency to sink lower and drag or plow a furrow, as is too frequently the case with sterns of this form when improperly adjusted for trim.

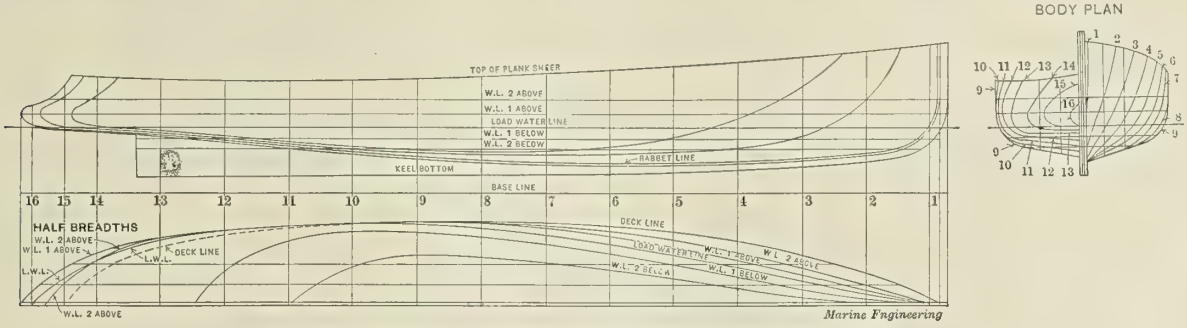



FIG. 36.—LINES AND BODY PLAN OF WOLVERINE CRUISING LAUNCH.

With regard to the midship section, the general form for the older ship model shows usually a rather sharp rise from the keel, approaching in many cases to the so-called peg-top form. As compared with a flatter and more nearly rectangular form of section this form has the effect of increasing the draft for the same total displacement, and of thus improving the seaworthiness of the boat in rough water, or of insuring a suitable immersion of the propeller at the stern without too great a drop of the skeg below the keel line.

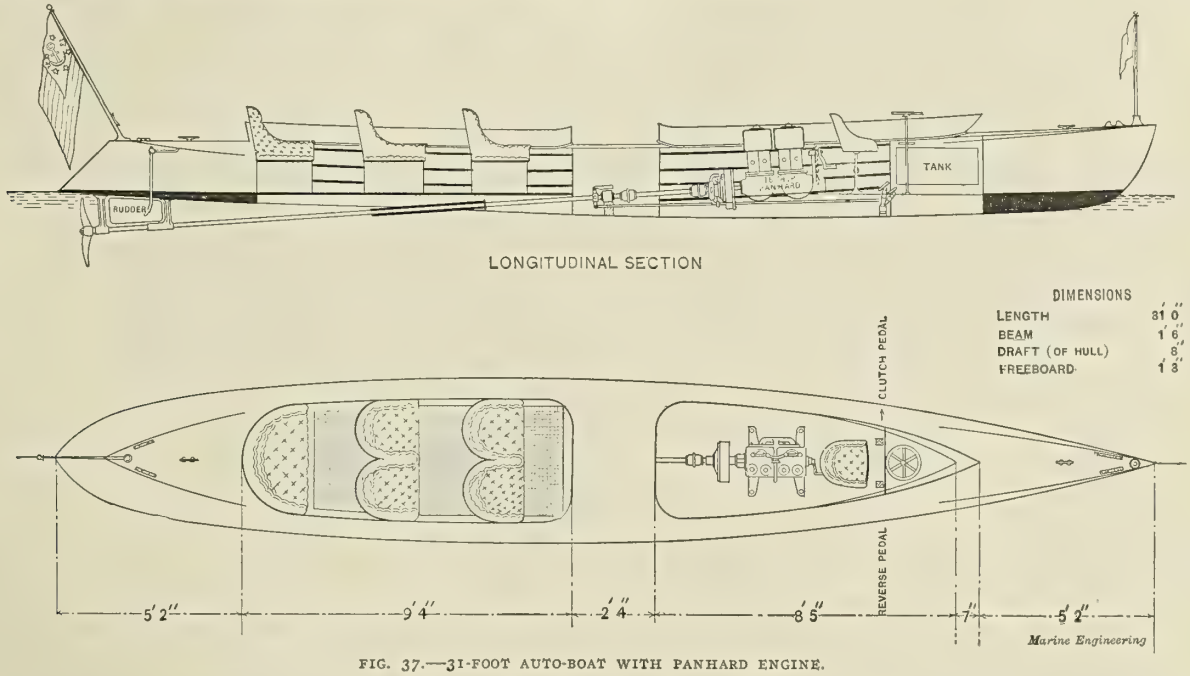



FIG. 37.—31-FOOT AUTO-BOAT WITH PANHARD ENGINE.

For the torpedo boat or flat-stern model the midship section is more nearly flat on the bottom, and is thus more full in form than the typical section for the ship-shaped model.

These various characteristics in either form when combined with a pronounced longitudinal paring away resulting in a distributed leanness or fineness of form, provide the conditions most suitable for the highest speeds, especially with reference to wave-making resistance. As the demands for speed are less pronounced the form will respond by becoming fuller at all points, and especially along longitudinal lines, thus giving more internal

capacity and more displacement on the same over-all dimensions and proportions.

Between the full flat torpedo-boat form and the ship model are found various "compromise" forms partaking in varying degrees of the qualities of both. The main purpose of such forms is to retain in good measure the characteristics and qualities of the flat model, and at the same time to provide a form somewhat better adapted to rough-water conditions.

Considerations of space forbid any further discussion of underwater form, and in no case can the preceding be considered as more than a general indication of the lines along which designers are working, especially when high speeds are of primary importance in the schedule of required qualities.

In general the flat or torpedo-boat stern represents the typical form for modern motor boats, and especially for all cases in which high speeds form an important consideration. On the other hand, the older type of stern may often be preferred for lower speeds or for cases which may be influenced by special conditions of the service required, while intermediate between the two, various types of compromise form are to be found, dependent on special conditions of the service or on the fancy of the designer.

concerned, as the six cruisers of our *California* class, of which four have been tried, and the battery power and armor proposition seem to have been taken care of about equally well in the two classes of ships. The English ship, however, has a very decided advantage in the question of speed, not only in absolute speed due to a higher power available from the engines, but in the economy of obtaining that speed as well.

A full power trial, lasting eight hours, was had a short time ago, in which the *Drake* averaged 24.3 knots on an expenditure of 31,700 horsepower. Figuring this up by means of the Admiralty formula, we find that her Admiralty constant for the trial in question was 261.

The full power trials of the four ships of the *California* class tried to date gave an average for the four of 26,864 horsepower, corresponding with a speed which averages 22.303 knots, at a displacement averaging 13,760 tons. The Admiralty constant obtained as before is 237.

If we could apply the *Drake's* Admiralty coefficient to the American ships the power required for the speed obtained in the American ships would have been only 24,400, or a saving of nearly ten percent. If, on the other hand, the American ships,

THE ENGLISH ARMORED CRUISER DRAKE.
(Photograph, Levick, New York.)

### Armored Cruiser Drake.

By long odds the most important and most interesting of the six ships constituting the Second Cruiser Squadron of the British Navy, which visited New York during the month of November, is the flagship *Drake*. This ship, which was laid down in April, 1899, at the Royal Dockyard in Pembroke, and launched in March, 1901, has a length between perpendiculars of 500 feet; over all, 529 feet 6 inches; a beam of 71 feet, and a mean draft of 26 feet, with a corresponding displacement of 14,100 tons. Her indicated horsepower under the design was 30,000, corresponding with a speed on eight hours' trial of 23 knots. The coal capacity on normal draft is 1,250 tons, with a total bunker capacity of 2,580 tons. The machinery consists of two sets of four-cylinder triple expansion engines, balanced on the Yarrow-Schlick-Tweedy system, and operated by steam from forty-three Belleville boilers fitted with economizers, and having a total heating surface of 72,000 square feet, and grate surface of 2,313 square feet. The *Drake* is of about the same size and date, so far as design is

with their own Admiralty coefficient, had sufficiently powerful machinery to be brought up to the speed which the *Drake* actually attained, the power required would have been 34,800, or about ten percent greater than in the case of the *Drake*.

If, again, the American ships, with the same power as was actually obtained, could have had the *Drake's* Admiralty coefficient, the speed would have figured out at 23.02 knots, or nearly three-fourth knot in excess of the present figure. Whether the discrepancy is due to less well designed lines of hull, or whether it is due to propellers not so well designed, is a question which cannot be settled offhand. It is worthy of note, however, that the *Drake's* speed with her present propellers, which are of much larger blade area than were the ones originally fitted, but of the same pitch, is 1.25 knots better than was the case with the old propellers.

The *Drake's* battery consists of two 9.2-inch guns mounted in single turrets on poop and forecastle; sixteen 6-inch guns, 45 calibers long; fourteen 3-inch guns; a number of machine guns, and two submerged torpedo tubes.

# THIRTEENTH ANNUAL MEETING OF THE SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.

The thirteenth annual convention of the Society of Naval Architects and Marine Engineers was held in New York on Thursday and Friday, November 16 and 17, 1905.

The first session was called to order on Thursday at 10.25 A. M., with the president, Francis T. Bowles, in the chair. The report of the secretary-treasurer was received and adopted. The statement of resources and liabilities show that the Society's finances are in excellent condition. The total resources are $24,490.50; liabilities *nil.* The council presented lists of applicants for admission to the various grades of membership; the names were read, and upon motion the applicants were unanimously elected. The membership of the Society on November 15, 1905, was 866. The new members are:

*Life Associate,* 1.—Alva C. Dinkey, president, Carnegie Steel Co., Pittsburg, Pa.

*Members,* 14.—Thomas Andrews, Jr., assistant manager and naval architect, Harland & Wolff, Belfast, Ireland; James Edward Davidson, assistant general manager, James Davidson, shipbuilder, Bay City, Mich.; Harold Arthur Everett, instructor in naval architecture, Massachusetts Institute of Technology, Boston, Mass.; Marley F. Hay, superintending constructor, Electric Boat Company, 11 Pine street, New York; Oliver Zell Howard, marine engine and boiler draftsman, and instructor in mechanical drawing in the department of marine engineering and naval construction, U. S. Naval Academy, Annapolis, Md.; Edward C. Johnstone, general superintendent and chief draftsman, Mosher Water Tube Boiler Company, 1 Broadway, New York; Louis C. Loewenstein, instructor mechanical and marine engineering, Lehigh University, South Bethlehem, Pa.; Asa M. Mattice, chief engineer, Allis-Chalmers Company, Milwaukee, Wis.; Charles Albert McAllister, engineer-in-chief, U. S. Revenue Cutter Service, Treasury Department, Washington, D. C.; James S. Milne, superintendent Neafie & Levy Shipbuilding Company, Philadelphia, Pa.; Charles D. Mower, associate editor *The Rudder,* 9 Murray street, New York; Francis B. Smith, chief engineer, Pittsburg Steamship Company, Cleveland, O.; Horace Holden Thayer, Jr., chief hull draftsman, Pusey & Jones Company, Wilmington, Del.; William Wallace Watterson, superintendent of construction, Pittsburg Steamship Company, Cleveland, O.

*Promotion from Associate to Member,* 2.—Joseph Wright Powell, assistant naval constructor, U. S. Navy, assistant to the superintending constructor, Works of the William Cramp & Sons' Ship and Engine Building Company, Philadelphia, Pa.; W. P. Robert, naval constructor, U. S. Navy Yard, New York.

*Associates,* 18.—John Lord Bliss, of John Bliss & Co., 128 Front street, New York, manufacturer of marine chronometers and nautical instruments; John Wesley Coates, machinist, U. S. Navy, U. S. S. *Denver*; Leonard Martin Cox, civil engineer, U. S. Navy, supervising engineer, steel floating dry dock, Cavite, P. I.; William Burder Ferguson, Jr., assistant naval constructor, U. S. Navy, Navy Yard, New York; Julius Augustus Furer, assistant naval constructor, U. S. Navy, Navy Yard, New York; Frank David Hall, assistant naval constructor, U. S. Navy, assistant to the superintending constructor, Cramp's Ship Yard, Philadelphia, Pa.; Sidney Morgan Henry, assistant naval constructor, U. S. Navy, Navy Yard, Mare Island, Cal.; Frank Bowne Jones, yacht agent and ship broker, 29 Broadway, New York; Martin L. Katzenstein, 114 Liberty street, New York, manager marine department International Steam Pump Company; Charles E. Littlefield, navigator, Nautical Schoolship *St. Mary's*, pier foot E. 24th street, New York; Frederick K. Lord, draftsman, 29 Broadway, New York; William McEntee, assistant naval constructor, U. S. Navy, Navy Yard, Mare Island, Cal.; George Theodore McKay, of firm of Stearns and McKay, naval architects and yacht builders, Marblehead, Mass.; John Mitchell, vessel owner, of the firm of Mitchell & Co., Rockefeller Building, Cleveland, O.; Carle Ermanus Pfister, lieutenant, Royal Italian Navy, attaché to the Italian Embassy, Washington, D. C.; Austin E. Potter, Editor *Power Boat News;* Eugene M. Richardson, vice-president, Sherwin-Williams Company, Cleveland, O.; William Rawle Shoemaker, lieutenant commander, U. S. Navy.

*Juniors,* 5.—Robert Earle Anderson, fourth class ship draftsman, department of construction and repair, Navy Yard, New York; John Arnhold Engerdt, inspector steam turbines, inspection and testing department, Westinghouse Machine Company, East Pittsburg, Pa.; Sidney Graves Koon, editor Marine Engineering, 17 Battery place, New York; Arthur Schultz Lewis, mechanical engineer, in charge of test room, construction and repair department, Navy Yard, New York; Daniel M. Luehrs, student in naval architecture, Massachusetts Institute of Technology.

## THE PRESIDENT'S ANNUAL ADDRESS.

It is the President's duty to briefly recall to you annually the events in our country in the art of naval architecture, but during the thirteen years of the life of this Society this duty has rarely been an agreeable one, if measured by the record of commercial success in shipbuilding. Following the Spanish war, owing to the purchase of vessels by the government, and the increased traffic with Cuba, Porto Rico, Hawaii and the Philippines for one or two years, commercial progress in shipbuilding showed a tendency to measure up to the technical progress shown by the members of our Society in its proceedings. Since these years there has been a steady decline in shipbuilding, both for ocean and coast traffic, until the former has reached the vanishing point. Shipbuilding is in a satisfactory condition only on the great lakes. There the shipyards are busy, and a steady improvement is made in the economy of transportation by the development of terminal facilities and the use of larger vessels. The success of the lake shipbuilders is unqualified, and shows the results which can be obtained by intelligent application to a problem. The coast shipbuilders on the other hand have little work, and deal with a great variety of problems, and their progress is therefore subject to the handicap of diversity of work and the small quantity involved. In the past year three or more coast shipyards have gone out of business, two have sold their plants and several more are in the hands of receivers. This is a melancholy record. A few events afford us some hope for the future. During the past year the Merchant Marine Commission appointed by Congress spent some seven months in a careful investigation held throughout the seaboard and lake cities of the United States, and presented a bill to promote the national defense and to establish American ocean mail lines, which met the approval of the committees in both houses of Congress. I quote a few words from their report:

"The American shipping in the foreign trade has been for forty or fifty years the only American industry exposed directly to foreign competition that has not been protected by the government. There is no need to look beyond this one sentence for the explanation of the hard fact that this one American industry has halted and shrunk, and while all others have made prodigious increase. * * *

"The American merchant marine is essentially a floating factory which is built and maintained on the American wage rate, but there is this vital difference, that while the land factories are covered by national protection averaging almost fifty percent, these floating factories, the few that are left, work up and down the ocean without any protection whatever, save that granted to a few steam lines by the postal subventions of the law of 1891. * * *

"An adequate American ocean fleet would mean the saving to this country of $100,000,000, which now goes to build up the commercial power and naval strength of Europe and Asia."

The bill suggested wisely includes provisions intended to create

and maintain a reserve of seamen for our naval forces. There have been added to the navy during the past five years large armored cruisers, and there will be added during the coming year seven or eight first class battleships and two armored cruisers, and the resulting demand for increased enlisted force in the navy has brought keenly home to our naval officers the force of the maxim that "no nation can maintain an efficient navy without a prosperous commercial marine to support it."

During the past year evidence has accumulated that there is ample field for development and extension of the coastwise steamship traffic, and it is unquestionable that this can be promoted by the careful study of naval architects to the necessities of the trade if carried on simultaneously with the improvement in terminal facilities. This tendency will no doubt be much enhanced by the encouraging efforts for the development of the marine turbine in the United States.

PAPERS AT FIRST SESSION,

THURSDAY MORNING.

## SOME PROBLEMS IN FERRYBOAT PROPULSION.

BY COL. E. A. STEVENS, VICE-PRESIDENT.

ABSTRACT.

The propulsion of double-ended screw boats offers some difficult problems in screw design. The subdivision of the power shown by the indicator is very complex, and its exact distribution well-nigh impossible. Tests were made of propellers for the *Scranton* class of boats recently put into service by the D., L. & W. Railroad, and wheels of different qualities were found to give very discordant results, the second wheel placed on the *Scranton* having required an additional 20 percent of power at the designed speed of ship without any appreciable gain in backing power as compared with the first wheel. The race from the forward screw, most seriously affecting the wake at the stern, introduced an element of uncertainty as to the power absorbed by each screw. As a result efficiencies are very different from what is obtained by similar screws in ordinary ships.

DISCUSSION.

Prof. Sadler: Mr. Stevens might explain a little more the statement that the thrust deduction minus the wake gain in those boats is probably negligible in design. It seems to me that in an ordinary ferry boat with the bow propeller the thrust deduction will remain about the same as in an ordinary boat, but the wake gain will be less. I should expect that the hull efficiency in these boats would certainly not be more than 95 percent, and probably less. This is, to a certain extent, I think, borne out by the efficiency curves. All the curves of total efficiency are very low for this type of boat. That is, the ratio of $e$ to $i$ never gets over 45 percent. I should also like to ask if he has performed any experiments, or has noticed any torsional vibrations in the shafts of these vessels. I think there is no doubt that there will be considerable torsional vibration set up.

Mr. Du Bosque: Col. Stevens has said that it is impossible to analyze the performance of screws on ferry boats. We have been experimenting with these inclined wheels for the last eight years, and have been trying to analyze the forces to determine what size and type of wheel should be used on any particular ferry boat, and we reached conclusions and tried the wheels and have not got good results. Now it is a fact that the forward wake of a screw propeller ferry boat has a very peculiar influence on the bow of the boat. I think we will have a great deal of difficulty in finding out what it is; but it is undoubtedly a fact, as the author has demonstrated, that an inclined wheel is very superior for a ferry boat to one with a straight axis. This fact was discovered by us some eight years ago, experimentally. A considerably larger diameter is required with a curved back wheel than with one that is straight, and I think the conclusions of the paper seem to point to that too, because the No. 1 wheel on the *Scandinavia* seems to show greater efficiency than the No. 3 wheel; we find 13 knots speed is gained with a trifle less horsepower. There is one feature about this type of wheel, however, that is more important, and that is maneuvring qualities. It seems that with the wheel blades pointing backward the water has a very much better chance to get to the rudder, and on all boats that we have fitted with inclined wheels the steering qualities have been immensely improved. That is a very important feature. The backing qualities are very much improved, because the wheel, being larger in diameter and more effective in pushing, exerted a backing force on the forward end of the boat in a pushing direction. I am inclined to think that the form of blade as given on the *Scandinavia* could have been very much improved, not only to increase the speed of the boat, but to increase the maneuvring qualities. We are now building those blades very wide and fairly narrow at the tips—in fact, somewhat like one of the turbine wheels described in one of the papers to be read here to-day.

We took a 9-foot wheel, with 11 feet 6 inches pitch, off the *Cincinnati*. In place of that, we put a wheel 9 feet 6 inches diameter, 12 feet pitch. The revolutions were increased from 115 to 120, and the speed of the boat was increased above 1 knot. We never made a progressive trial with the new wheels, but the performance is very accurate, as we keep records of the actual time taken by every boat on every trip, and by applying a number of these we get a comparison of the speed of the boat.

Mr. Stevens: The only method I know of in which the algebraical sum of thrust deduction and wake gain could be obtained is by single screw type; so that in those which have been attempted, as the *Cincinnati*, the *Bergen* and the *Edgewater*, the hull efficiency worked out at very close to 99, somewhere over 98. When you come to the double screw condition it is practically impossible to separate the race augment from the total sum. The efficiency falls to a very low figure; but I know of no process to obviate it. I have tried a number of times to get at some process by which the thrust deduction could be estimated apart from race augment, but I have been simply floored.

As to torsional vibration, the shafts of these boats are usually much larger than would be used in ordinary practice. I think that the very fact that they have been operating now for some eighteen years practically without shaft troubles, shows that the shaft is working under very low stresses. I have never taken any such measurements as would give me any practical data on the subject, but I have never been able to trace the vibrations to an unknown cause, which I would then call torsional vibration.

The statement as to the relative diameter of the straight wheel entirely bears out my experience. As to steering, I have not had sufficient experience to state. The only boat I had knowledge of was the *Scranton*, where the steering was very satisfactory under both conditions. If anything, it is a little better with the curved wheel. In backing we find on the *Scranton* that the first wheel, the ten-foot wheel, was very sluggish in starting. This was due somewhat to the setting of the valve gear and the arrangement as to the valve, which lifted quickly and gave very little compression. The vessel with the original wheel was very sluggish in backing. The chief engineer considered it was due to the wheel's being too large. The *Scranton* No. 2 wheel was even worse in backing, although considerably smaller in diameter. The question as to tips is to a great extent a practical one. Too fine a tip will not stand up in ice conditions. However, a wider blade than that shown would probably give better results.

## EXPERIMENTS WITH VENTILATING FANS AND PIPES.

BY D. W. TAYLOR, U. S. N., MEMBER OF COUNCIL.

ABSTRACT.

The experiments were undertaken for the purpose of learning more than was known about the capacities and efficiencies of fans used for ventilation purposes on United States naval vessels, and to obtain information to enable systems of ventilation to be intelligently designed. The tendency at present is to place main

reliance for ventilating living spaces upon the plenum system, which forces the air in, but exhaust systems are also fitted for special purposes. The conclusions drawn from experiments are briefly:

The angle of branches should be less than forty-five degrees. Elbows should not have a smaller radius to the center of pipe than 1½ diameters. Outlet fittings should be connected to branches by connections that gradually taper. The mains should be circular in section whenever practical. The size of branch should be determined by a consideration of the loss of head and consequent enlarged delivery. Rectangular pipes should be avoided whenever practicable.

DISCUSSION.

MR. LINNARD: Those of us who have had to design ventilating systems for ships know how much difficulty and doubt existed in the past as to the thing—any sort of designing data was accepted, and I think it may be said that these are the first public results which give experimental data and designing rules which will enable anybody familiar with laying out ventilation piping to design a system which can be relied upon to be satisfactory after its installation, a thing which has hardly been achieved heretofore; and this has been attained, as I am personally aware, after a very long and exhaustive set of experiments to which Mr. Taylor has devoted a great deal of time and attention.

MR. MACALPINE: There is one point with which I have been very strongly struck, and that is, the very low efficiency which he has found for fans, an efficiency which he states for the conditions of ship ventilation comes to about 50 percent, in some cases rising to 60 percent or more, but usually for higher pressures than allowed. This is a very different result from what is usually accepted among many who have made fan tests, and the question is of great interest where the difference comes in. Mr. Taylor relies altogether on the pitot tube, and says that he is convinced its accuracy is well established by independent investigations. That is a point on which there is a very great deal of difference of opinion.

Mr. Taylor's experiments go up to 22 pounds per square foot, which, with a square delivery, would expand at 140 feet per second. With such velocity even approximately steady flow is an impossibility, and in fact there is a proof of that in the body of the paper itself, where there was a velocity of 100 to 200 feet per second spoken of. As to the necessary assumption that the center of the stream line is brought to rest, of course that would be so where the stream line is perfectly axial. If it were one degree from being axial it would not be true. If it were five degrees it would be very far, indeed, from being true. In fact, Mr. Taylor says that in his experiments it was thought necessary to use ten or more tubes in large pipes in order to reduce to a negligible quantity the error due to the velocity of the air. That is a well known fact; and if he had given us the pressures at the different parts of the pipe, we would have found also that the pressures were very far from uniform.

Commanders Carnegie, Dinger, and Johnson also used pitot tubes as one of their modes of measuring. The nozzle experimented with was 24 inches diameter, in which twelve measurements were taken. In one case, while one of the tubes showed 6¼ inches pressure, another tube showed 7¼, or 16 percent over the lower. Now I am not taking up one of the experiments alone, nor were these pressures, these large gradients, transverse gradients, 24 inches apart. In two of the experiments we have the pitot tubes within about six inches of one another, registering ⅞-inch difference of pressure. This is not a perfectly constant feature, showing that it is not an experimental error that has been introduced; but it is so far constant as to show that it is a real fact that high and low pressures occurred at these points near one another. Now, if we have such heavy pressure gradients transverse to the tube, it naturally means that the stream lines are very much curved, that is that there is a great deal of vortex motion. The pitot tube takes no proper note of this vortex motion.

A very frequent way of testing is by delivering the air into a very large box so that the air currents, instead of being exceedingly swift, are very much reduced. There is still kinetic energy, which will register itself in the pressure gauge, but it is very much reduced, so that the pressure gauge has not a very powerful current blowing across it. A large kinetic energy is transformed into potential energy.

In a test on July 16 both methods were used. By the pitot tubes there was a calculation of 55 percent efficiency. The observations from the gauge in the box gave 69 percent, a difference of 14 percent. There have been a great many fan tests made, in which the efficiency has been believed to be considerably over 60 percent. I have seen fan results where, even with pitot tubes, it was calculated from the observations that the efficiency was as high as 70 percent. That at Trunham, which I have referred to, was 69½ percent, taken from the pressure in the box.

MR. CLIFFORD: The question of the method of measurement of the pressure and horsepower of air has always been a matter of much discussion, and in many cases much confusion. I am glad to note that the anemometer has been discarded and the pitot tube used. I have used a pitot tube for the measurement of velocity for several years, placing the tube at the end of the delivery pipe for the fan. I placed it so that the static pressure entirely disappeared, and the velocity pressure was the only one to be measured. That is my method of dodging a problem which the author of the paper has so satisfactorily solved, that of actually measuring the static pressure of a moving column of air.

I must also agree with Mr. Taylor as regards the efficiency of the fans. The tests that we have made show that the efficiency is about as he states. Of course, there is one thing to be considered, and that is that in the application of a fan wheel the efficiency that Mr. Taylor has given is a maximum efficiency.

MR. TAYLOR: Mr. Macalpine appears to consider the efficiencies very low as compared with efficiencies which have been frequently attempted. That is all correct. I have seen fans as high as 96 percent, and I suspect some data would show efficiencies over 100 percent if you followed it out practically, but I may say that I am not the only worker in this field, and I know of one large firm which has made a large number of experiments of late with various types of fans, and one of their representatives was inclined to criticize my results as giving too high efficiencies. They have used the pitot tube and other methods too. The accuracy of the pitot tube method I believe is beyond dispute. The same question was raised several years ago in connection with hydraulic work, before another society, at which time the pitot tube was very much discredited. There are two things that you measure with this pitot tube—one is the impact pressure, and the other is the side pressure, which I have called the static pressure.

Prof. Zahn, of the Catholic University, has made a very large number of experiments with air. He has a tunnel in which he soaks the air. He can stop up the end of that tunnel and produce a slight amount of vacuum in it. He has made a very small opening in the end and has taken the pitot tube and placed it first outside. Keeping it in the center of the jet, he moves the pitot tube gradually in until it comes entirely in the tunnel. The head is unchanged; that is to say, the impact of the air, the velocity of the air due to the head. The air is brought entirely to rest in front of the tube and the head remains constant.

The side opening has been the real difficulty with pitot tubes. Take a pipe with one end closed. If you make a small hole in the side you will get aspiration across it. It is entirely unreasonable to suppose that the pressure in a moving stream of air could be accurately transmitted to the inside of a pipe like that. There is a small opening of that kind, where you will find that the tube I use has on each side quite a long, narrow slit, parallel to the direction of the moving air, and I think it is obvious in principle that that is much more apt to convey the pressure.

There is a further experiment which has been made by Prof. Zahn with a tube. He has taken a pitot tube of this kind and

determined simultaneously the velocity by the pitot tube and by the independent method, and the results vary very little. It is true that there are differences of velocity over the pipe section, but the original apparatus had separate manometers measuring the impact pressure and the side pressure from each separate tube. There was a varying velocity, over a section of the pipe, an erratic velocity. It was usually highest in the center, but at times it would be found a little to one side. These variations may have been perhaps 10 percent. The tubes were not placed at the immediate outlet of the fan, but a little distance down the pipe, where the extreme turbulence with which air leaves the caisson had had a chance to somewhat subside.

The trouble with blowing air into a box is that air enters the box with a certain amount of kinetic velocity and thereafter carries with it a certain amount of kinetic energy, and it is very uncertain how much of that kinetic energy is transformed into pressure. Mr. Macalpine says much of the velocity is transformed into kinetic energy, but there is no way of finding out how much that is, and when you are attempting to obtain accurate results it is necessary, I think, to use apparatus and methods which will approximate theoretically to the result.

Mr. Clifford performs an experiment with a restricted delivery. That is a very good test to find out certain things. You find out what the fan does through a contracting nozzle, but you gain very little information as to what the fan will do when discharging into a full-sized pipe. We tested some fans with the restricted delivery method, and gave very satisfying results. They were electric fans. The fans were put aboard ship, and owing to the resistance of the actual piping being a good deal less than that of the conical appliance, they delivered a great deal more air. They all performed more than the manufacturer expected, but they used so much power in delivering the air that they destroyed the motors.

The question of a slightly increased first cost in a thing like this is comparatively a minor one. As fitted aboard ship, our friends in one test delivered 1½ cubic feet of air per minute per watt. The best results for combined efficiency were under 30 percent.

The President: In closing this discussion the Chair might state that these experiments were undertaken for the practical object of enabling the design of a ventilation system to be made with reasonable certainty, and to avoid complaints which were coming in from chief engineers and surgeons that the ship was full of pipes but there was no air. A conversation such as this took place: Mr. Taylor said that a number of fans had been received at the model basin, and he wanted to know what they were there for. He was told that they were there for him to find out what they could do. The paper before you is the result of three years of scrupulous scientific investigation, and fully justifies the labor and expense which has been put upon it.

PAPERS AT SECOND SESSION,

THURSDAY AFTERNOON.

## EXPERIMENTAL RESEARCHES ON THE PERFORMANCE OF SCREW PROPELLERS.

BY W. F. DURAND, MEMBER OF COUNCIL.

ABSTRACT.

The present report covers in effect the performances of forty-nine model propellers distributed over the field of pitch and area ratios, from pitch ratio 0.9 to 2.1, and from area ratio 0.18 to 0.72 respectively. The experiments were carried out in the canal of the hydraulic laboratory at Cornell University. This canal or tank is about 340 feet in length by 16 feet in width and 10 feet in depth. The canal is provided with water from the reservoir above, through double shut-off gates and an intermediate lock or measuring chamber. Once filled the water is quiescent, and the level may be maintained where desired by an adjustable weir at the western end.

The curves showing values of $T$ and $Q$ on $s$, the values being reduced to standard revolutions per minute, are lines nearly straight, or curved slightly concave to the axis of slip. This general character of the relation between $Q$ and $s$ or $T$ and $s$ is distinctively characteristic of the propeller, and has been indicated by all previous experiments carried out in detail, and covering the determination of the data in such form as to bring out this relation. There is, of course, no reason for assuming that such law is naturally linear, or that there is any natural reason for expecting a straight line relation between these quantities. The general trend of the curves, as shown, indicates clearly, however, a somewhat slower increase of $T$ and $Q$ with $s$ than the exact linear law would require.

The general efficiency relations indicate for a low slip, such as ten percent, a general increase of efficiency with area, except for the lowest pitch ratios, when such increase is followed by a decrease for the highest areas. For higher values of the pitch ratio and low slip, however, there is, as a rule, first a marked and then a slow increase of efficiency with increase in area, the best results being given for area ratios of thirty-five to forty-five. On the other hand, for high values of the slip, such as forty percent, there is, as a rule, a continuous though perhaps slow decrease of efficiency with increase of area throughout the range. Intermediate between these extremes we find for moderate or average values of the slip between twenty and thirty percent but slight change of efficiency with area. For the lowest pitch ratio, however, the decrease of efficiency with area for these intermediate values of the slip is still well marked.

THE DISCUSSIONS ON PAPERS III. AND IV. WERE MADE TOGETHER.

## SOME RESULTS OF TESTS OF MODEL PROPELLERS.

BY A. V. CURTIS AND L. F. HEWINS, JUNIOR MEMBERS.

ABSTRACT.

The investigations were carried on under the direction of Naval Constructor D. W. Taylor, and are supplementary to those described by him in the Transactions for 1904. These experiments were carried on with two-, four-, and six-bladed propellers, there being nine of the two-bladed, twenty-four of the four-bladed, and eight six-bladed, as well as two special three-bladed propellers. All were sixteen inches in diameter and of uniform pitch, except for the two special propellers, and the pitch ratios were 0.4, 0.6, 0.8, 1, 1.2, and 1.5, as was the case last year. Very interesting curves were obtained, particularly in connection with contours.

DISCUSSION.

Mr. Macalpine: The accumulation of propeller data is excessively interesting and important; but with a model propeller and a full-sized propeller at corresponding speeds, the pressures per square inch on the surface of the model propeller are very much lighter than on the full-sized propeller, and consequently while the full-sized propeller may have such a pressure that cavitation is about to set up, the model propeller will be very much removed from that. That is to say, the action on the water will be very much more nearly uniform in the case of the model propeller than on the full-sized propeller, and consequently, since the government is at the back of the experiments, I would again suggest that they be supplemented by propellers on actual ships, and that there ought to be new and properly made trials to open up the subject. That is very important, because at the limited pressures that we have to work at in many cases nowadays we cannot be quite sure of making the steps from the model experiment to the full-sized experiment without such a guide.

These model experiments give an efficiency ranging up sometimes as high as 80 percent. I have no doubt the efficiency is due to the fact that the model blades are only about half as thick as a full-sized propeller with heavy pressure. By making the blades of the ordinary proportions, the efficiency would probably fall to 69 or 70 percent as a maximum. I should judge that Mr. Taylor probably now ascribes some considerable influence to the thickness of the blade.

In this paper we have an eye to two series of experiments with model propellers; of the thin type and also of those that are

reduced from the natural propeller. For instance, Nos. 19 and 76 are compared. In the thin blade there was an efficiency obtained of 73 percent. In the corresponding thick blade the efficiency fell to 60 percent. In the case of propellers 24 and 81 the efficiency fell from 75 percent to 61 percent; that is to say, it came down in one case 13 percent, and in the other case it came down 14 percent. Now the interesting confirmation is given that the efficiency was largely influenced by the thickness of the blade, for propeller 81 was planed off on the back toward the edge, so as to get the sharper angle on the back, to a pitch of 30 percent less than that of the face.

The forms of the curves for the very thin blades and for the thick blades were very different, indeed. That is to say, the maximum efficiency not only fell, but it was obtained at a very different slip in the two cases. In the case of No. 19 the 73 percent efficiency was obtained at 14 percent slip, and in the case of No. 76, 60 percent efficiency was obtained at 32 percent slip, so that the curves were very different in form. We have the thin blade giving 75 percent efficiency at 13 percent slip, and the corresponding thick blade giving 61 percent efficiency at 20 percent slip. Now I think it would be exceedingly useful if the experiments were to be continued in the model basin to investigate very fully the influence of the shape of the section, and the thickness.

MR. STEVENS: I plotted out the curves of efficiency for two propellers tried in the model tank that were reproductions of actual propellers—that is to say, No. 76 and No. 81, both the original and modified, and compared them with the curves of the propellers of the *Scandinavia, Edgewater* and *Scranton.* The latter sections are all sections of ferry boat wheels, and decidedly heavier than are met with in ordinary practice. Of the six curves thus obtained, five ran in a fairly parallel strip from 12 percent slip up to 40. One curve, the No. 76 propeller, with a peculiar fish-shaped section, does not reach the bunch of the other curves until it gets up to a slip of about 30 percent. The other curves all have a very decided efficiency at zero slip. The maximum efficiency reached by any of these wheels was by that of the *Scandinavia* at 18 percent slip. One went up to 66.5 percent. The lowest is in the *Edgewater,* also at 18 percent slip, which is 59 percent, those being the maximum efficiencies for both of those wheels. In other words, in these wheels—they are all of them of rather fine pitch, very full area ratio and thick blade sections—the efficiency varies from a maximum of 66.5 percent down to, at working point, somewhere about 55 percent, through the practical range of the slips, which is not very far from figures which one would usually expect to find for propellers of that kind. Personally I have used on wheels of that sort generally from 58 to 62 for the efficiency.

For wheels of an area ratio of .295 and a pitch ratio of 1, I found that taking a four-blade wheel as a standard, at 100 percent, a three-blade wheel will absorb 81 percent; two-blade, 77 percent; and taking an area ratio of .4025, with the same pitch ratio, 1, and taking a four-blade wheel again as 100 percent, the three-blade wheel absorbed 76 percent, or practically the same as in the other case; and the six-blade wheel absorbs 124 percent.

## THE CRUISER.

BY COMMANDER WM. HOVGAARD, ROYAL DANISH NAVY, MEMBER.

ABSTRACT.

This discussion may be considered a continuation of the author's paper, "The Sea-Going Battleship," presented last year. Perhaps the most important experience learned from the great naval battle of the Sea of Japan is that long-range fighting is possible to an extent not heretofore anticipated, a direct consequence of which is an enhanced value of heavy guns as compared with guns of somewhat heavy or medium calibers. Another consequence of long-range fighting is that the assumed average fighting distance on which armor protection should be based may be chosen greater than before, and that consequently armor thicknesses may be somewhat reduced. Assuming an average range of 4,500 yards as compared with 3,500 last year, a battleship may be permitted a reduction in armor thickness of about one inch. However, as ships were in several instances struck below the armor belt, the weight saved should be partly used to extend the depth of side armor.

In passing from the battleship to the cruiser, the general principles will apply with but few modifications; the design should in every respect be based on probable average conditions. The large ship may be made superior to the smaller in speed, gun power, and protection; and is inherently superior in nautical qualities, economy of propulsion, watertight subdivisions, and relation of sea speed to trial speed. The armor protection should correspond with the battery; that is, it should be such as to enable the cruiser to maintain a long-continued fight with an equally powerful antagonist under average conditions. The armor protection should be proportionate to the relative importance of the part to be protected; the protection of the ship should take precedence over that of the guns; the armor weight should be applied chiefly to the sides, no more weight being given to the armor deck than necessary for its functions as a splinter deck.

It is concluded that although the first-class armored cruiser of to-day is a vast improvement on what it was a few years ago, it is only partially suited for the duties which it may be called upon to perform, and cannot be considered a fully satisfactory type. It is, therefore, concluded that for all strictly military service a new and more powerful type—the battleship cruiser—should be substituted.

For a country like the United States, which has little ocean commerce to protect and to whom commerce destroying is not likely to appeal, it appears that the shipbuilding policy should be directed exclusively toward purely military objects. A few types appear to be sufficient for all strictly military duties: battleship cruisers of the same military strength as battleships but of higher speed (20,000 tons, 21 knots); scouts of extreme speed, great endurance, perfect sea-going capacity, and light armament (5,000 tons, 25 knots); small cruisers of moderately high speed, fair endurance, relatively powerful armament and protection (3,000 tons, 20 knots). The two first types are required only in small numbers, the last in greater number.

DISCUSSION.

MR. SPEAR: There is one aspect of this paper that I find it very difficult to follow, and that is the line of reasoning by which the author arrives at the conclusion that the ship for doing scout duty should have a displacement of 5,000 tons. He says in the body of the paper that the number of units is not so important to the scout as the individual ability of the ship. That seems to me entirely wrong reasoning. While the development of wireless telegraphy has extended the usefulness of each individual scout, we have not discovered any way of finding the other fellow by wireless telegraphy, and the amount of scouting which you can get out of a certain sum depends upon the number of ships you can put out to scout. We have in the present large destroyers the basis of the proper scout. The ships which we call 420-ton ships are, as a matter of fact, when we go to sea, 600 to 620 tons. They have pretty well demonstrated that they can take care of themselves under all circumstances on the sea, and that they can maintain a sea speed under all reasonable circumstances which is quite sufficient for practical purposes, or at least near enough so that a displacement of about 1,000 tons can serve every possible purpose that the scout can serve. But the basis of it all is the number of ships you can get to do a certain duty for a certain amount of money. The thing that limits the scout is that it can see only just so far, and a 100-ton ship can see just as far as a 1,000-ton ship.

MR. TAYLOR: The author has gone into the matter of deck armor vs. side armor with great accuracy and thoroughness, and considered it mathematically in the appendix, and finally come to the conclusion that armor should be given to the sides, and no

more weight should be given to the armor deck than necessary to its functions. I fully agree with him in that. In our service for a number of years now we have followed as much as possible this dictum.

President Bowles: In making up one's mind as to the most efficient types of ship it is fair always to give some weight to the fact that you do not always expect to meet in large numbers the ships most recently designed, and, therefore, if any apology is needed for the existence of the *Tennessee* class of cruisers it is in this, that by the possession of superior speed they can choose their enemies, and that the chances are that with the armor protection and the guns they carry they would be able to engage a very large proportion of whatever enemies they might meet. It appears to me that the Japanese war has produced quite a change in the essential qualities of fighting vessels, and possibly we do not now and shall not for some time yet fully appreciate what those changes mean.

It would appear that the value of speed in battleships is much greater than we supposed it was. It would also appear that the value of handiness and small turning circles is not so great as we supposed it was, and I think that we have sacrificed unduly other qualities to those. In seeking for opportunities and for means of increasing the speed of battleships without undue increase in size and cost, these considerations which I have mentioned will operate somewhat.

The question of handiness also brings one to the use of the ram. If officers would be willing to give up the ram it would very much add to the possibilities of increased speed. I believe that the weight carried in the bow of the ship and the shape that is involved there in making an efficient ram, is a great detriment to high speed. It seems to me that the question to-day of speed of battleships is largely one of the production of the required amount of steam without excessive addition to weight, and that the gain in steam without increase of weight is to be attained in one of two ways, or it really reduces itself to one way by the elimination of hand-firing. That is, we must come to the use of mechanical stokers or the use of oil fuel, and to a type of boiler more nearly that called the express boiler.

The use of the steam turbine should enable us to get speeds in a battleship of reasonable cost which will absolutely eliminate the armored cruiser of to-day and produce a ship infinitely superior to any battleship now afloat. When that result is attained, and I believe it to be now attainable, there will be no excuse for an armored cruiser, unless a far greater speed can be obtained for them on reasonable cost than we now ask for. That is, we should have to have a speed of 25 knots instead of 22 in order to justify the cost of an armored cruiser that would be capable of meeting only the inferior battleships. That would be a question which could be decided only by careful study, the prospect being that that high speed would not be justified when the greater part of the services of such a vessel can be performed by very moderate-sized scouts.

Mr. See: The subject of abandoning the armored cruiser and raising the speed of the battleship has for some time been a prominent one in my mind. I, however, believe the vessel should not be a big, costly one, built on present lines, with high, towering straight sides to present a big target, but a more modest, radically different, as well as less prominent one. Superior speed, protection and gun-fire are all important in the battleship, but not necessarily attainable only by increasing the size of the present ship.

Those responsible for the type of battleship now in evidence have been unable to get rid of the sentiment about the walls of Old England or to recognize the fact that you can have too much wall, that the height of a battleship should not only be as low as the amount of freeboard demanded will permit, but also have its sides inclined where possible so as to deflect and not stop the projectile thrown against it, and that the armor should be of such a thickness and so arranged around the vital parts as to meet a projectile on the outside and not take chances by allowing it to enter. Also that the armament should consist of guns of the largest serviceable caliber, few in number, in order to do the work with a much smaller crew; and to be located in well-protected turrets, so as to inspire confidence and with it obtain better handling. And, finally, that the model of the vessel and the power installed should be equal to securing a rate of speed capable of commanding the best position.

I would, therefore, suggest instead of the present form of battleship an improved one containing the new features given above, and embodying also the salient points of the *Monitor* and *Merrimac* as a new type, combining the high speed cruiser and the sea-going battleship in one. The vessel will be of about 10,500 tons displacement, having but one deck above an armor belt 11 inches thick, from which the sides tumble home at an angle of about 40 degrees, starting at 6½ inches at bottom and tapering to a thickness of 5 inches at the upper deck. The tumble home will work out beyond the forward turret into a raised forecastle in order to obtain sufficient freeboard to maintain speed in sea way, freeboard amidships and aft to be 10 feet. The guns will be 12 inches, arranged in pairs, in one turret forward and another aft on upper deck. This deck will be 1½ inches thick, and the interior protective deck is to be abandoned except at ends, in view of the heavier armor amidships, by which arrangement weight will be saved, construction simplified and vessel strengthened. Another modification involves increasing the thickness of bottom plating and reduction of frame spacing for about one-half the length of vessel amidships, in order to increase strength and resist torpedo attacks. The plating will be 1¼ inches, except at turn of bilge, where it is to be 1 inch thick, and frames 36 inches center to center. By this rearrangement of material, whereby the amount in the neutral axis will be taken to increase sectional area of the upper and lower members, increased strength of structure will be obtained without increase of weight. Bilge keels are to be retained, but those for docking, inviting damage from the torpedo, are to be abandoned in view of stiffer bottom. Instead of a speed of 19 knots in battleships built or now building, we propose to increase it to 22, or equal to that of the armored cruiser, made possible by reduced weight of superstructure, armor, armament and by the adoption of a model well suited to attain it, together with the employment of engines and boilers of a design for obtaining from the least weight and with the least smoke or waste of fuel the highest efficiency under all conditions.

Such a vessel will surpass the large low-speed one with thick armor and heavy guns as well as that of high speed with thinner armor and lighter guns. In the first place, its height will be at least one deck less, so as to present a smaller target, with the sides above the belt sloping upward to deflect instead of stopping the projectile, and without openings to invite its introduction. Then the extra thickness of the belt will permit fighting at closer quarters, accompanied with a more destructive work on thinner armor of guns equal to those of the low-speed vessel and superior to those of the high. With the reduced number of guns there also comes the reduced complement, consequently less space required for their accommodation and supplies, together with the possession of a more compact organization, and with it higher efficiency. And last, but not least, this superior fighting machine can be obtained in less time, at very nearly one-half the cost of a vessel presenting a larger target, offering inferior protection, possessing less strength, equipped with no heavier guns, slower by more than three knots and calling not only for double the complement to fight her but also the additional expense connected with their employment. Such a vessel will present a type combining the best features of the battleship with those of the high-speed cruiser, and one superior to the battleship for all-around work, equal to the armored cruiser in speed and superior to it in fighting, one from which can be obtained the best and surest results with the least amount of money and in the shortest possible time, together with being more readily manned in view of the smaller complement of men.

Two such vessels as proposed, carrying a combined armament of eight 12-inch guns against four 12-inch and four 9.2-inch, with 11-inch belt against 9-inch, with a speed of 22 knots against 19, with a target at least 7½ feet lower, inclined instead of vertical, and a crew no greater in the aggregate, can be obtained at a cost but 6 percent greater than that of the battleship *King Edward VII.* The latest battleship is to have twelve 12-inch guns mounted in six turrets, four of which are to be broadside; which means that guns of but two can be used to form with those at each end one broadside, so that but eight guns will be available for this purpose. This vessel will no doubt cost complete, fully equipped, in the neighborhood of $9,000,000. If it is compared with the cruiser-battleship in the matter of gun-fire alone, the latter's superiority will be found to stand out more prominently, as seven ships, costing about the same amount of money as the three bigger ones, will present a broadside fire from 28 guns as against 24, or nearly 17 percent more.

It is then reasonable to assert that the cruiser-battleship will be highly efficient, be more useful and give more trouble to a foe than the bigger ones, consequently of greater value, the superior speed making it easier to govern the tactical situation as well as possible to engage an enemy in detail and secure the best position to harm the leading ships without engaging the rest of the fleet. The reduced height with thicker armor affords at like range superior protection against attack, thereby lessening the amount of injury from gun-fire. The guns being of one caliber the smaller crew can be more quickly disciplined for the work, so that better results are possible in less time. The importance of this latter condition will be more fully realized when it is borne in mind that officers as well as men have to be secured as well as trained, so that the smaller complement and simpler conditions to be faced will shorten the time required to complete the complement, as well as to obtain from it the highest efficiency —one of greatest importance in times of peace as well as war.

Commander Hovgaard: I do not object at all to the idea that large destroyers should be used as scouts, and are very suitable for doing part of what here is called scouting service, but it will always be for scouting service in a very narrow sense. If we read the remarks here made about the qualities that should be possessed by a scout, it is stated that they should possess a sea speed higher than that of the armored cruiser, with greater endurance, and the battery should be sufficiently powerful for fighting other scouts, etc.

Now all these conditions are necessary for an ocean scout. These qualities cannot be secured in a small ship; they cannot be obtained in any form. Alone, the requirement of seaworthiness and high endurance is enough to make these small ships altogether impossible, and their armament is always defective. They cannot keep anything like the speed of 3,000- or 5,000-ton scouts. They can be used only at short distances from the field of the vessel they are scouting. If it were a question of scouting duty over great distances, then such destroyers would clearly not be useful; if they were sent out several hundred miles ahead of the fleet they would be exposed to be lost. What is required is a few ships that can pierce the enemy's lines with tolerable safety, and not run away as soon as they meet a third-class cruiser or destroyer; and I think, therefore, that such large scouts with real sea-going qualities will always be required; but that design, of course, will not prevent the use of the smaller ships for scouting. Wherever the conditions are favorable for their use, on the contrary, they ought to be there used.

Mr. See's design has too low a freeboard. Ten feet is the freeboard we have had in several ships in this and other navies, and it has been proved that as soon as the speed came up to about 14 or 15 knots, ten feet freeboard was not enough. The ships were wet, the guns could not be worked; and the next type that was designed was given higher freeboard, and as soon as the speed was raised, even that was not found enough. The freeboard was then increased still more. And in this way we have, from years of experience, arrived at a type of both battleship and cruiser of some 18 to 20 feet freeboard, at a speed of 18 to 20 knots; and it may not be unlikely that we shall have to build a forecastle on those ships. But to have a ship going 22 knots with ten feet freeboard would be impossible, while the gun axis is no higher than it is in the *Indiana* or the *Kentucky* or *Kearsarge*. If you could drive the *Indiana* at 22 knots I doubt very much whether it would be possible to work the guns. It looks very tempting to obtain a great result on a small displacement, but whenever it has been attempted—and it has been attempted a great many times—it has always proved a failure, for the reason that you cannot secure the fundamental qualities of seaworthiness. If the guns cannot be worked when there is a little rough sea, all the saving in displacement and money is of no use; the ship will not be able to do anything like what is required from it. The fact that a ship has no secondary guns is undesirable. As ships are now constructed with 10-inch guns, a secondary armament is highly desirable if not absolutely necessary. I would say that if the battleship cruiser were made with only 12-inch guns, that would not be a good type as far as armament goes. But when it comes to cutting down the fundamental quality of seaworthiness of a ship, we have gone as far down in that as is possible in modern battleships, but to cut that down still more I think is practically unsafe.

Judging from other ships, I should say that with a shape like that with 23-foot draught, there would be a very short range, and not a very great maximum of stability.

## COMPARISONS OF RECENT BATTLESHIPS.

BY NAVAL ARCHITECT H. G. GILLMOR, U. S. N., MEMBER.

ABSTRACT.

Including vessels to be laid down before the close of the present year, the six maritime powers of the world, Great Britain, France, United States, Germany, Italy and Japan have under construction forty-seven battleships, varying considerably in size and characteristics. From time to time, as facts regarding the vessels laid down by the several powers become known, comparisons on the basis of gun-fire, protection, speed and other features are made. That such comparative studies are of interest in the development of naval design is evidenced by their frequency and the number of systems upon which they are based; ranging as these have from what has been aptly termed "comparisons by instinct" to mathematical comparisons of considerable complication.

The purpose of the present paper is to compare from the point of view of the designer and builder, the latest battleships of each of the six powers named, regarding which reasonably accurate information is available. The vessels selected for this comparison are: Great Britain, *Lord Nelson;* France, *Démocratie;* United States, *Vermont;* Germany, *Deutschland;* Italy, *Vittorio Emanuele III;* Japan, *Katori.*

In the number and position of the large caliber guns less variation is observable among the vessels here considered than would generally have been the case with a similar comparison of vessels of the same nationalities in the past. The system of protection employed for these large caliber guns is, as well, almost uniform. They are all mounted in armored turrets or their equivalents near the ends of the vessel; with barbettes of large diameter or smaller diameter armored tubes for the protection of the turning, elevation and other gun mechanisms and the ammunition supply. In the extent of protection for the water-line, there is substantial uniformity, all of the designs providing for complete water-line belts. The thickness of the armor for these belts, however, varies considerably. In the matter of speed there is, except for the 22-knot Italian, which her designer has termed "a compromise type," greater uniformity than would have been the case generally in the past. One of the things most notable is the wide range in displacement of the vessels, rising from 12,624 tons for the Italian to 16,500 tons for the English ship. The past decade has brought a substantial increase in the displacement of battleships

for all the naval powers, and indications are not lacking that the limit in size has not yet been reached.

While a general idea of the relative naval values of the several vessels considered may be had from an examination of tables giving their chief characteristics, the differences among the vessels preclude anything like an accurate comparison from the point of view of the designer without recourse to some system. For naval purposes, the value of a vessel is determined chiefly by the battery and ammunition carried; the protection given to the guns, personnel and stability; the coal carried as affecting the time during which a vessel may operate without recoaling; and the speed. This value is independent of the displacement, although a relation between displacement and attainable naval value fixes the value of the latter for any displacement, and the excellence of a design should be judged by the nearness of its approach to this limiting condition.

On the basis adopted by the author, the relative naval values of the six ships in the order in which they were previously listed is as follows: 7,985; 6,995; 7,780; 6,235; 6,335 and 7,515. The efficiency of the design, represented in percentage of above values to design displacement, is as follows: 48.4, 47.7, 48.6, 48, 50.2 and 47.2, which shows a remarkable uniformity in results.

## THE ULTIMA—A GLOBULOID NAVAL BATTERY.

BY ANSON PHELPS STOKES, ASSOCIATE MEMBER.

ABSTRACT.

Following the paper on this same subject presented last year, modifications in the design have been made, and the present vessel has a length of 270 feet; beam, 190 feet; displacement, 30,000 tons, including 2,400 tons of coal; draft, 36 feet; the indicated horsepower with natural draft is 10,000; with forced draft, 13,500. The main battery consists of two 15-inch and sixteen 12-inch guns of great length, while the secondary battery includes twenty-four 3-inch guns.

## A NOTE FROM JAPAN.

BY GEORGE W. DICKIE, MEMBER.

ABSTRACT.

The main items in warship-building are to face high explosives, protection against mines, high speed in battleships, rapidity of firing guns; these are the most important material factors that bring victory in naval battles. It is believed that a strongly-armored fighting ship, having a speed that could be maintained at all times at 20 knots, would accomplish probably more than either the battleship or the armored cruiser. On this basis the author has figured out a warship having the following dimensions: length, 450 feet; beam, 75 feet; draft of water with 1,500 tons of fuel in bunkers and two-thirds of full supply of ammunition, 26 feet; displacement, 15,000 tons; battery, fourteen 10-inch guns arranged in sponsons on gun deck, and fourteen 14-pounder rifles on upper deck.

In two hostile fleets, the one which commands the highest speed in all his ships can choose the distance at which he will fight. The question of supplying fighting ships with fuel at sea will also be solved by liquid fuel. Much of the mechanism installed in warships for operating fittings that can readily be operated by hand is not only a waste of money and mechanical skill, but is positively an element of danger in time of battle.

PAPERS AT THIRD SESSION,

FRIDAY MORNING.

## LONGITUDINAL BENDING MOMENTS OF CERTAIN LAKE STEAMERS.

BY W. I. BABCOCK, MEMBER OF COUNCIL.

ABSTRACT.

In the last two or three years there has been a great change in the conditions of lake business. This has been caused mainly by the great development that has taken place in the dock appliances for the unloading of bulk cargoes of iron ore. Great hydraulically or electrically-operated self-filling buckets or grabs of 5 or 10 tons' capacity dig their way into the cargo, and nearly all of it is unloaded without any hand work at all. In operating this modern power bucket in the hold it is evident that the fewer obstructions there are the better, and that the hatches should be as large and as close together as possible. Also that the ore pile should be concentrated on a small bottom area and, therefore, be deep or high. From these considerations there has been evolved a modern vessel in which the hatches are 9 feet wide, spaced 12 feet centers, the main deck beams and stanchions entirely omitted, and the tank top bent up to meet the main deck stringer in various forms, but all with the idea of forming a long hopper or trough in which the ore lies, and which presents a smooth surface everywhere to the buckets.

The strength is made up by carrying a heavy plate girder or arch across under the upper deck between each two adjacent hatches, connected to heavy plate webs running right around the ship. The waves met on the great lakes are uniformly short though they may be relatively high. The maximum size likely to be encountered is a wave 200 feet long and 20 feet high, and the calculations have been made on that basis.

A comparison of the various curves obtained indicates that under any condition of the loaded vessel, whether in still water or among waves, the sagging moment is in excess, and generally very much in excess, of the hogging moment. Considerable criticism, therefore, which has at various times been indulged in, as to the heavy bottoms of lake ships in comparison with their upper works, is shown to be largely unwarranted. This construction of the vessel has been a natural outgrowth of the conditions of the business, which require a very heavy bottom to resist the strains due to frequent grounding and touching in narrow and shallow channels, and also to support the weight of the cargo on the tank top, and which also require the upper deck hatches to be as numerous and as wide as possible to facilitate unloading. These conditions combine to make the bottom heavy and the deck light, and to, therefore, lower considerably the position of the neutral axis. It is satisfactory to know that strains which come upon the ship in deep water among waves are very well met by the same construction; for the compression on the upper deck is always much more severe than the tension, and to resist this compression it is comparatively easy to stiffen the stringer by one or more lines of intercostals between the beams.

DISCUSSION.

Professor Sadler: Mr. Babcock has raised some very interesting points with reference to lake steamers. What most struck me was the ratio of the length to the depth of these vessels. In the case of the *Gary* 17.7, and of the *Victory* 16 only. This, of course, is the outcome of the difficulties to be encountered, the limited draft which these vessels can be allowed owing to the shallowness of the straits and the difficulties of the service. He mentioned a wave 200 feet long and 20 feet high as about the most severe wave these vessels are likely to meet. I do not know if any definite measurements of these lengths and heights of waves have been made, but it seems to me that that wave is a little too short and steep.

The maximum bending moment as developed in this condition is naturally, as one would expect, rather low, the factor one-seventy-seventh being about one-half or one-third of what might be expected for ordinary sea-going vessels of the same size. It is very interesting to see that Mr. Babcock has added a set of curves for the bending moment for the deep-sea conditions, so we can get direct comparisons. I may say that I have a similar set of calculations under way for different heights of waves, and shall be pleased to submit them at a later period.

Another point that is raised in this paper is the question of the regulations of loading of the lake vessels. That is a question that has come up recently and I think Mr. Babcock hits the nail on the head when he says that it is the usage of carrying

the greater portion of the ballast at the stern, leaving the bow light, and with reference to the carrying the greater portion of the load in the middle of the vessel. This is good practice, but leaving the light condition forward is not to be countenanced. That this is done with the lake vessels shows, I think, that an intelligent set of rules for loading as well as unloading would be an advantage to the shippers. There might be some objection to that on the part of ship owners, but no doubt they would come to that if this legislation were intelligently made.

There is another point which I think might be investigated, and that is the strain upon these vessels in the inclined condition. These vessels, as is generally known, roll rather heavily, and I think it will be found that in the inclined position the strains are more severe than in the upright. I would like to ask Mr. Babcock if he would later on give the actual stress that came upon the sheer strake and keel for these vessels.

COMMANDER HOVGAARD: I think that it would add considerably to the interest of the paper if Mr. Babcock would give us the maximum stress in addition to the bending moment. Of course the bending moment may be very interesting in ships which are so alike, so similar, but when we come to comparing ships of different construction and different bending moments it does not give us a means of comparison.

MR. COX: The vessels for the lakes are different from anything in the world, because of the restrictions as to length and draft. For that reason I consider that the addendum to the paper, which shows that if these vessels were used on the Atlantic, where they were liable to meet waves of increased length, he has assumed that the stress produced, particularly the tensile stress, would be four times that which is met with at the lakes, probably shows why it is these vessels have been built. As with the other speakers it occurred to me that the matter of maximum stress would be very important, and I hope that Mr. Babcock will be kind enough to give that in some of these vessels.

MR. DICKIE: I have been wondering for a long while why these lake ships were not built with a "U" shaped hold in the center and hatches hung on the sides so as to fold up. From the conditions I have thought all the time that the reason it was not done was because the means they had of handling the cargo were sufficiently good, and the difference between the cost of handling the cargo in the present way and with the "U" shaped hold was not enough to pay to make any changes.

With reference to the stress on these ships, I do not think myself that this actual stress would be of such value as others seem to think. If they established that point, any good indicator would give the actual stress on the ship, and while the coefficient would be of value, it would not be of great value without the actual stress added to it.

MR. LUKERS: The stress is one of the means of comparison. No doubt the theoretical or calculated stress would differ from the actual stress, still that would form a better kind of comparison than would the bending moment. By this calculated stress we have a means of comparison, and it should never be looked upon as useless. We know of vessels running across the Atlantic Ocean, in constant use, with a stress of nine tons, which are secure, and we therefore are pretty safe in designing new vessels for a stress of nine tons. So far as comparisons go this is a basis to start with, if we make our calculations all in the same way. A great many calculations have been made as to Atlantic steamers, while the lake steamers have hardly been touched. I think the question of stress would be interesting to us.

I would like to know whether under special conditions the ships show any buckling in places that have to be straightened out, or if there is a tearing. Some years ago one of the lake steamers was lost, and it was stated at the time that it was due to tearing that produced a break. Perhaps the information with which Mr. Babcock is supplied may enable him to tell us which is the probable or possible cause: whether the sagging moment produced or caused a buckle or break in that way.

MR. MCRAE: I have had some experience in these calculations, and a short time ago I was asked by some authorities in this city to make these calculations for an oil steamer of the usual depth and 450 feet long. This was a case wherein they wanted to put the machinery amidship, and the question was which was the strongest ship. I went through all these long calculations for this particular ship, and found that with the engines amidship and central bulkheads cut was the strongest, and also that the maximum stress on each ship was in the sagging condition; in this vessel it was 144,000 foot-tons bending moment and gave a maximum stress for engines amidships of 13 tons; with engines aft it was 18. This was taking waves at the length of the ship and twenty feet or under that in height. Of course, we all know such conditions as that would hardly occur in running a vessel, because a captain meeting such waves does not run over them.

MR. THAYER: Mr. Babcock has incidentally stated the fact that the stresses on salt water are some four times as great as on fresh water. To us on the Pacific coast have come a number of lake vessels, and we have probably had some as decided failures of them as have been anywhere. The lakes build cheap ships, and we are all the time thrown up against lake competition. They want to send us their ships at their prices. Their prices cannot be met on the Pacific. For their quality of ships they could be, but that quality does not suit the demand. Another point in connection with these lake ships is the position of the weights shown in this paper. As everybody knows, it is the practice to carry a load to a port and leave with a load. The Pacific coast service is decidedly against that practice unfortunately. Most of our cargoes come down the coast from the north, and ships must go up against heavy northeast winds and long seas, which have in many cases resulted in very serious damage to our ships.

Three ships came to the coast on a yearly charter. The first came with eight hundred tons of ballast, for that kind of service, and soon had her forward end beaten in by the seas. Repairs were made, and she started again, and in another month or two she had the same result, so to finish out the year's charter she had to carry a thousand tons of rock ballast. Another ship that came to us is in the service there at the present day, and has been there for five or six years. When she arrived she had about eight or nine hundred tons of ballast. That was not sufficient, and they eventually put into her a deep tank of 950 tons, and made a success of her. But the lake vessels that have come to us have always failed to meet the conditions of the coast, and I would like to see the fact worked out and placed properly before the ship people, the difference between the salt water and the fresh water practice. I run up against people who have had experience on the lakes, and they will assert that the same conditions obtain there as on salt water, but facts show it is different.

The lake vessels that have come to us have failed on account of the light weight for the forward end of the ships, and the excessive weights aft. They have not sufficient ballast to go up against the head seas, and on the coast that is one of the important things, because of the lack of cargo going north. Generally the trouble has been in the bottom. The conditions of the Pacific coast are such, in the trade that I have mentioned, with freight down, and going up in ballast, that it is very hard to build a ship suitable for the trade. These ships come to us with eight hundred tons of water ballast, which is not sufficient, and we have to increase that to practically one-third of the cargo capacity.

MR. CRAIG: The gentleman has made the statement that they were cheap ships. I would like to know whether they were cheaply built, or good ships at cheap prices.

MR. STRATTON: The *Mackinaw* and the *Kebinor* were the first two ships that were ever built on the lakes and brought to the Atlantic. They were built according to the rules of the American Bureau of Shipping, and built under my personal supervision. the *Mackinaw* was the first to come down. She was brought to Montreal in two sections. She went into service at Montreal and

did service between there and Rio Janeiro, and between here and the Pacific. It is generally known that the *Kebinor* went out of existence in a collision with another ship, and the debris from each of them was afterward picked up. The *Mackinaw,* the sister of the *Kebinor,* is there to-day.

Mr. Fair: One of these ships had a dent in her stern that was made with her own bow. The ship was taken down in two pieces, and when she got to Montreal the stern rammed the bow.

Mr. Reid: A few years ago the modern power buckets were invented, and from the necessity thus created has been evolved the modern vessel, and vessels of that pattern, of which a large number have jumped into existence within the last three or four years. I would like to show you some elements of their early revolution and changes. Some years ago an English friend of mine who had great trouble with the style of vessels then in use wished to evolve a steamer very similar to what you have on the lakes. They wanted to operate such vessels, and wished to design special discharging facilities. The tank was to be formed both fore and aft, and the wing space should be preserved for the water ballast. The ships were to be built entirely for ore carriers. That was away back in 1898, and when I was coming out to the lakes in 1899, they asked me to look around here and report to them on the subject. I saw the Hulett working, or rather it was broken down. The bucket got round one of the deck beams and tried to lift it out. I was told, and reported to my people, that the Hulett was to be the pattern for the lakes, as new ships would be required. I told them it would answer very well, and in order to get more room they could cut into the excessive wing space. My friends thought it would not be a bad idea to design a ship in this way, and they got up a design. That was in 1901. Some three years later that same idea seems to have struck the American shipbuilders. But that did not do very well because the power buckets struck the sides of the hopper and damaged the vessel. And after they decided it would be best to broaden the bottom of the hopper. And it was found that you could get just as good results, and get the use of much water ballast. The ship could be built that way, with the ore in one bulk amidships, and then the ore buckets would have enough space, and we could take out the beams and have the hopper open from end to end. I think after a while the builders will come to the conclusion to adopt this plan.

Mr. Babcock: The curve of weight for the original ship is made from data obtained from captains of ships, and they put so much ore in each hatch. For instance, there are in a little more than half the hatches a certain number of car loads, say twenty cars or twenty-two cars. Of course, the ore has to be loaded to bring it to even keel practically. As a matter of fact, they leave Lake Superior a little bit down at the stern because as the coal is burned the stern gets lighter and they want to come into the receiving port on an even keel. Now it was found that the same number of cars were put in every hatch except the forward hatch, right straight through the ship, twenty cars to the first hatch and twenty-five cars to the second hatch. There is not very much difference, it is a matter of a few pounds in each hatch.

Several gentlemen have spoken of an addition to the paper in the shape of exact calculations of stress. The midship-section as given is practically all the information in the paper to make such calculations possible, and I would be very glad to turn it over to anybody that cares to go into it. The title of this paper you will observe is "Longitudinal Bending Moments of Certain Lake Steamers"; not stress. Anybody that wants to go into the actual stress or bending moments in any inclined position of the ship is at perfect liberty to start.

In lake ships, of course, the proportion of the depth to the length is very small. That is a very necessary result from the conditions of the lakes. The present loading docks, from which the ore is spouted into the ships, are only a certain height. If the top of a ship that comes to that dock is higher than the chutes, the water ballast has to be run in to get her down so that the spouts can be lowered into the holds, and the ore run in from these cars above. You have then to pump the water out, and if you have put in a great deal of water it takes a great deal of time to pump it out, even with the very large pumping facilities which are provided on lake ships. Experience has shown that without any question the ships are deep enough. Of course as the channels of the lakes are deepened so that boats can load deeper they can be made deeper.

I have never had the fortune, or misfortune, to be out on the lakes in a heavy storm; but I have talked to many people who have, and asked their opinion of the size of the waves. The greatest length that I have ever heard of was 150 feet, and I added 50 feet to that in order to make sure to get as big a wave as ever would be met. I do not know any accurate measurements that have ever been made.

Mr. Dickie's idea that lake vessels could be built with one hatch in them, and hatch covers that would fold into the center, is not practical at all. When the shutters were swung up on the inside part of the ship you could not load any way; they would come against the ore spouts of the docks. If he can get up any better hatch that can be used on the lakes there is a tremendous field for him there. Many people have been working on that for a great many years. The telescope hatch seems to be the best thing, and there are a great many objections to that.

I do not think I have ever heard of any indications of great stress by the bending of the sheer stringers. I have known it to be shown by the upper-deck stringers in the old method of stringers, say four feet apart and perhaps not stiffened; when the vessel was loaded it would show perhaps 5/8 or 3/4 of an inch, but I never heard of any failure of that kind; it would bend simply down between the beams. The modern practice is to stiffen the stringers by intercostals between the beams, and modern ships do not show anything of that kind at all.

As far as I can understand, the failure of lake ships on the Pacific coast has been shown forward, because of the fact of their going up light against heavy seas, and the bow has been smashed in by the sea. I have heard of that before, and I have no doubt that is what happened. I do not think lake ships have been the only ships that have shown trouble of that sort. I would like to say further that very likely the builders of the ships which have shown that trouble are not responsible in the slightest degree. The shipbuilder has to build a ship according to specifications given him, and if the owner does not know the conditions, and does not instruct the shipbuilder, the builder is not responsible. The shipbuilder is bound to build a ship as instructed, and if there are special reasons why a ship should be strengthened in special parts, he should be so told.

## SOME NOTES ON STEAM-BOILER TROUBLES.

BY HORACE SEE, MEMBER OF COUNCIL.

ABSTRACT.

This paper is presented in the belief that it shows how some of the troubles of the steam boiler can be traced directly to bad design, and points out the characteristics found responsible for their occurrence. Some of the lessons believed to be taught are as follows: Restrictive circulation, whether partial or complete, will lead to the destruction of the parts coming under its influence in proportion to the degree of severity and length of time of its continuance. The margins of water lanes in the steam boiler alternately contracted and expanded at the narrowest points will be worn away in proportion to the strength and volume of the stream moving through them. Pockets permitting sediment to be deposited will lead to destruction. The life of a tube may be increased by galvanizing its surface.

DISCUSSION.

Mr. Reid: It would be interesting if Mr. See could tell us about the accumulation of scale on galvanized steel tubes; whether there is as much accumulation as in the ordinary tubes of iron.

MR. DUBOSQUE: Mr. See has laid down here certain rules that should be observed in designing power boilers. I do not suppose there is anybody connected with boilers who does not know these things. What we should like to know is how to accomplish them. The boilers referred to in this paper are obsolete, and the methods of caring for them are of only relative importance to us. But we are all familiar with Scotch boilers, recognized as good boilers; yet I venture the assertion that hardly any designer of Scotch boilers is fully convinced how near the last flue should be to the top of the boiler. We repeatedly have boilers designed by eminent boiler makers, in which the flanges come down to the furnace, no matter how great is the care. I want to speak of one case of the effect of superheated steam on the metal of Yarrow boilers. Superheated steam affects the shell; why should it not affect the tubes? I think if the cause lies in any direction it is in the sulphur in the gas on the exterior of the drum. The result is clearly shown in the tops by the wasting away of the metal. I think it is a mistake that the drum of the Yarrow boiler, being affected inside by the superheated steam, should be subjected on the outside to the sulphur gas liberated from the coal.

MR. SEE: I have found that the smooth galvanized surface appears to shed the scale more readily than the surface of tubes not so protected. In fact, in this particular case, the unprotected tube was being roughened by the adhesion of scale and the galvanized one was not.

In relation to furnaces and high-pressure boilers, some years ago one of the boilers of the ferry boats gave trouble. There was quite an argument on the cause, which was claimed to be due to improper furnaces and everything else. Some poor fellow advanced the theory that it was grease, and they sat down on him. Where furnaces come down it is almost invariably from grease. In a case of the furnace coming down in a tugboat, they had a boiler with flat sides and round bottom, known as a Kidney boiler. The furnaces were connected with sockets, and had irons going around underneath. When that furnace came down a locomotive inspector got hold of it and said it was on account of the lack of support. I advised the gentleman interested that if the furnace came down again he had better obtain permission to come under reduced pressure and have repairs done at the works. Three extra pounds were put on and the furnace came down again, and then we found evidences of grease. But we never find powder after it has exploded, and after grease has been burned we do not find the grease. I sent an inspector to the vessel at Philadelphia to examine it and report what was necessary to be done. We put in a new furnace and fired up, and the inspector came and said: "You see we have on this pressure and nothing has happened. If that comes down again I will take your license away from you." It did not come down again. Attention was paid to keeping the grease out of the boilers. In the early days people used grease in unlimited quantities, and it did a great deal of damage. I have known cylinders where the joints between the parts were eaten away with tallow.

With reference to vertical water tube boilers and vertical tanks, it is difficult to tell just what the water level may be, and if the water comes down there is a possibility of the steam remaining in contact, and when it becomes of a sufficiently high temperature the metal will be affected so that the pressure will change the shape. That is one thing that should be avoided, and it is the general practice to protect that surface, so that the gas will pass outside and not touch the metal.

## NOTES ON THE STRENGTH OF WATER-TIGHT BULKHEADS FOR BATTLESHIPS AND CRUISERS.

BY HAROLD F. NORTON, ASSOCIATE.

ABSTRACT.

In the latest ships the requirements of the Navy Department are that all bulkheads below the protective deck shall be tested by filling the compartment on one side of the bulkhead with water under a head of 35 feet above the bottom of the keel. Bulkheads so tested must stand the pressure without appreciable permanent set, or deflection sufficient to cause serious leakage or to endanger the collapse of the member tested. The amount of leakage tolerated being so slight, the deflection of the plating at any point must be held down sufficiently to prevent any danger of breaking the calking.

Usually the stiffeners are vertical, equally spaced, and bracketed at the heads and heels. Since the plating cannot be depended upon to act as a tie, we must assume that the whole load of water pressure on a strip of plating of width equal to distance between stiffeners is carried by one stiffener. In supporting this load, it is reasonable to suppose that the stiffener conforms to the laws of flexure, and acts as a beam fixed at the ends.

The formulæ for the behavior of a beam of uniform section, so loaded, are not treated in the ordinary books on the flexure of beams, but were derived by the author for use in the discussion of the action of a certain bulkhead. These formulæ are, however, rather cumbersome for practical use, and it is the object of this paper to present certain curves derived from them, and from which the required results may be immediately obtained.

DISCUSSION.

COMMANDER HOVGAARD: It appears to me doubtful whether we are justified in considering the double stiffeners used in the United States ships as fixed at the ends. Mr. Norton pointed out the discrepancy between the deflection as determined by the formula and that actually observed in the *Illinois*, and he discussed this matter very fully. His conclusion was that by applying the factor to the calculated deflections he would obtain very nearly the observed deflections, and that the formula for a stiffener fixed at the ends could be used for finding the stresses.

By tests undertaken in several other battleships and cruisers, and which have been analyzed in a thesis work carried out by Assistant Naval Constructors Furer and McBride, it was found that the ratio between the observed and calculated maximum deflections varies considerably in different stiffeners, and that in some cases its value approaches 6. Moreover, it has been found that in the same stiffener this ratio is far from constant, but increases very rapidly toward the ends, and the measurements have in no case revealed the existence of points of inflection; if they have existed at all they must have been very close to the brackets. The curve of deflection approached in fact very closely to that for a stiffener freely supported at the ends.

The following table, which deals only with maximum deflections, and part of which was calculated in the said thesis work, illustrates this point:

| Name of Ship. | A Observed Net Deflections. | Calculated Deflections. B Stiffener Fixed at Ends. | Calculated Deflections. C Stiffener Freely Supported at Ends. | Ratio Between $\frac{A}{B}$ Deflections. |
|---|---|---|---|---|
| *New Jersey* | 1.10 in. | 0.19 in. | 0.96 in. | 5.7 |
| *Rhode Island* | 0.81 " | 0.18 " | 0.93 " | 4.6 |
| *Colorado* | 0.83 " | 0.22 " | 1.14 " | 3.7 |
| *Illinois* | 0.94 " | 0.22 " | 1.11 " | 4.2 |

I speak here only of double stiffeners, as I have not had an opportunity to study the case of single stiffeners. The great discrepancy which, in spite of careful bracketing, is found between the actual results and those that might be expected is, I believe, due to the following causes: (1) Lengthwise (vertical) shearing along the neutral axis at the ends of the stiffener, causing a tendency of the stiffener on one side to move upward, on the other downward. This tendency was evidenced by the lifting and buckling of the brackets, which took place by the first test carried out on the center line bulkhead of the *Illinois*, as described in Naval

Constructor Woodward's paper in Volume 6 of the Transactions When this action occurs the double stiffeners will behave more or less like two independent single stiffeners, the bending moment at the apex of the bracket will decrease, while that at the middle will increase and with it the deflection at the middle; the points of inflection will move toward the ends.

This action should be resisted chiefly by the rivets connecting the flanges of the stiffeners through the bulkhead. But there is only one line of rivets, which passes through four thicknesses of steel plus a layer of felt. The shearing stress to which these rivets are exposed may be extremely high (for the case dealt with in the paper I found the stress 19 tons per square inch).

(2) Bodily turning of the double stiffener in a vertical plane round a point near the apex of the brackets; the stiffener behaving to some extent as a beam hinged. (3) Bending of the stiffener due to insufficient stiffness (moment of inertia). This action was exemplified in the second test of the bulkhead in the *Illinois,* described in Mr. Woodward's paper; it occurs even if the stiffener is held perfectly firmly by the brackets, and the bending is of the same nature as that of a flexible string. Such bending will be accompanied by overstraining at the apex of the brackets.

Any and all of these causes may be operative in producing the increased deflection which has been observed, depending on the construction of brackets and stiffeners in each particular case. It is probable that the action is very complex, and with our present knowledge of the subject I consider it impossible to determine to what extent each of these causes influences the final result. In spite of the close correspondence which is found between the actual deflections and those calculated by the formula for a freely supported stiffener, I would not consider it safe to use that formula any more than the one used by Mr. Norton for finding the stresses. I believe it is best to acknowledge our ignorance, and therewith, the necessity for a further minute study of the problem. Only more systematical and refined methods of testing and measurements can reveal what actually takes place in the stiffeners.

In studying the behavior of these double stiffeners we are naturally led to inquire into another question, namely, whether the material in such stiffeners is used to best advantage. I have already referred to the imperfect connection of the channels through the bulkhead, but the chief objection to this construction is the accumulation of material near the neutral axis. Not only the flanges of the channels but the bulkhead plating itself contribute very little to the moment of inertia. The liners might be avoided by using flush plating as is done in the English ships.

If we make all the stiffeners of same scantling it appears that there can be no gain in space by double stiffeners as compared with single stiffeners of same total depth. Center line bulkheads may, if single stiffeners are used, be placed a little out of the center line; on coal bunker bulkheads the stiffeners may face the bunkers, and on the transverse bulkheads between engine and boiler rooms the spaces will remain the same as with double stiffeners, if the stiffeners all face the same way.

It would, therefore, appear better to place the stiffeners wholly on one side of the bulkhead, whereby the bulkhead plating may be made to serve as one of the flanges, and may then contribute enormously to the moment of inertia. In such case the connection of the stiffener to the bulkhead should be by two flanges, each large enough to take a double line of staggered riveting, so as to prevent the plating from tearing from the stiffeners when the water pressure is applied from the side of the stiffeners. Whether single or double stiffeners are used it appears doubtful whether the perfectly uniform distribution of stiffeners now used in the United States ships is the best.

By tests of bulkheads it has been observed that the stiffeners nearest the ends of the bulkheads take a much smaller deflection than those nearer the middle, a fact which has been pointed out already by Mr. Woodward in his paper. This can be explained only by the support which the stiffeners get through the bulkhead plating from the adjacent rigid boundary. It shows that such stiffeners might without danger be lightened, and that it is possible to construct the stiffening system of a large bulkhead of a limited number of very deep main stiffeners, spaced at intervals with much lighter scantlings. This is the system used in the English Navy. It is about 25 percent lighter than the American system.

If with this system the internal arrangements permit placing the main stiffeners wholly on one side, they may for a given section modulus be constructed much lighter than the double stiffeners, since the web may be lightened by holes; the depth can without difficulty be tapered off toward the top, and the bulkhead plating comes to form an integral part of the stiffener. I believe, therefore, that in this way we may effect a considerable saving in weight.

Mr. Furer: It would be very dangerous to use this formula which Mr. Norton has produced from the curves, because they are based on beams fixed at the end, and actual experience shows they are a great deal more rigid, and, therefore, contribute much more to the bulkhead. In the case of the *New Jersey,* where beams were calculated as secured at the ends the calculated deflection coincided within fifteen percent with the actual deflection observed; while in the *Illinois,* where the upper bracket is secured to the deck rather than to girders, and, therefore, does not have as much tendency to get out of line, the difference was twenty-five percent.

Mr. Norton: The curves which have been drawn by Capt. Hovgaard do not appear to agree with the curves observed in the *Illinois.* We were convinced by the *Illinois* that the stiffeners did not need to be fixed at the ends; because of the character of the observed curves; also because the brackets came away up between, along the middle, as though they were doing their very best to fasten the beams at the ends.

In the work we have done at Newport News, the bulkheads figured in this model have set the pace. The whole idea of getting up this paper was to show what we have used in practice. We are aware that there is a question in case of a serious outside rupture about the ability of the brackets to fasten the beams at the end. A great deal may be said regarding the remarks made that it is very improper to arrange the brackets at the ends so they would hold the beams. To do that demands an arrangement to connect the brackets at the ends of the stiffeners to proper support, and then figure the stiffeners to fasten to beams fixed at the ends. As a matter of fact, that is just what will suffice to better the construction, to provide brackets all along the bottom fastened to deck brackets and to the foot of these bulkheads.

The amount of deflection observed in these bulkheads, it has always seemed to me, was to be explained by the way they are built. The stiffeners are not all of one piece, and we could not expect to rivet a number of things together without having some internal stress, which appears as soon as the pressure is put on the bulkhead, and it seems to me these internal stresses appear by their acting just like an oil can, pressing out on one side or the other as soon as pressure is put on it.

PAPERS AT FOURTH SESSION,

FRIDAY AFTERNOON.

## MARINE APPLICATIONS OF THE CURTIS STEAM TURBINE.

BY CHAS. G. CURTIS.

ABSTRACT.

The first vessel to be propelled by steam turbines of this type, and the first vessel of any kind to be fitted with twin shafts and screws and twin turbines independently controllable and reversible, was the yacht *Revolution,* built in 1902. The practical operation of the turbines was in every respect most satisfactory and convincing, neither one ever having required any repairs of any

kind, and the steam consumption was shown by torsion shaft test to be substantially equivalent to that of the ordinary triple expansion engine under average working conditions. The boat, however, failed to develop the speed anticipated, and it was a long time before we could find out why this was so. Several sets of screws were built for the boat, the last set having a diameter of 4 feet and a pitch of 4 feet and having thin blades of well known form. From what is now known of the action of propellers of this character, and from the fact that the turbines did develop the power expected, we have been led to conclude that the trouble with the *Revolution* was in her model, which in the afterbody is very bad, her floor not being drawn out aft far enough. This view is confirmed by the best marine architects whom we have consulted about the matter, and who have observed the wave action of the boat, which is very excessive, even at a speed of only 18 knots, which was the best that could be obtained, though 21 was expected.

Some time ago the Fore River Shipbuilding Company entered into contracts for the construction of two large vessels to be equipped with twin independent Curtis turbines, which vessels, together with the turbines, they are now building. One of these is the United States scout cruiser *Salem*, and the other is the Southern Pacific steamer *Creole*. During the past summer the Vulcan Shipbuilding Company, of Germany, completed a turbine vessel called the *Kaiser*, which is fitted with two shafts and two independent turbines of this type. The actual figures guaranteed were a speed of 19½ knots, and a consumption during a six-hour run of not over 4,700 kgs. of coal per hour, including all auxiliaries. Progressive speed trials were had up to 20.46 knots, the propellers turning at 555 revolutions per minute. During a six-hour run 20 knots was averaged on 4.060 kgs. of coal per hour.

PAPERS XII. AND XIII. WERE DISCUSSED TOGETHER.

## MARINE STEAM TURBINE DEVELOPMENT AND DESIGN.

BY E. M. SPEAKMAN, ASSOCIATE MEMBER.

ABSTRACT.

The rapid development of the marine turbine has taken place entirely in Great Britain; a few experimental vessels have been built here and in continental Europe, but nothing has yet been done commercially. Now that the proportions of turbines and propellers can be determined with ample accuracy to enable very stiff guarantees to be made, both for speed and economy, a similar development may be expected in other countries.

The most important feature in the development of marine turbines has, undoubtedly, been the decision of the Cunard Steamship Company to adopt turbines for the new vessels of that line. For some time it has been evident that new mail steamers would be required, though for many reasons the date of ordering them was postponed again and again. Among the investigations that were carried out for determining the relative efficiency of the two systems, were trials made on the turbine steamer *Queen*, and the other vessels running on the Dover-Calais service, and also on the *Brighton* and *Arundel* on the New Haven and Dieppe station. These tests were amplified by data obtained from the Clyde turbine steamers and from two large destroyers tested by the Admiralty.

While many of the advantages claimed for the turbine over piston engines are inseparable from the use of such a motor, others are largely dependent on excellence of design, and the prescience with which these claims were made in the days of the *Turbinia* and *Viper* has been fully justified in the light of later experience.

If there seems any tendency to exalt the turbine unduly, it must be dismissed from consideration; the reciprocating engine is by no means obsolete. It has played a most useful part in the world's engineering, and if it should happen that it must go before the rapid advance of the rotary engine—and for many classes of vessel it is already supplanted—it may be remembered that sails had to make way for pistons, and that while the *America's* Cup is still to be won, it is unlikely that they will disappear entirely.

DISCUSSION.

MR. KIMBALL: I wish to ask what is the minimum speed of a vessel that can be recommended for the use of turbines, and also with how small horsepower they have been found efficient? That is, how small the units can be made before the advantage of the turbine ceases to be of material interest?

MR. WHEELER: How about the application of the steam turbine for ferry trips, with the double-end screw? I remember when I took the trip on the *Revolution*, the turbine was handled very readily for backing or going forward, and I should think that the application would be quite successful for ferry-boat service.

MR. MACALPINE: Mr. Speakman's paper is excellent, so far as it goes, but in some respects it does not go quite far enough. In the last part one might complain of a great deal of indefiniteness, and being given hints where much fuller knowledge might have been forthcoming.

Mr. Speakman very properly writes as an enthusiast for the turbine. But it is very difficult to be an enthusiast and at the same time be perfectly judicious. Those who have taken a particular interest in the turbine must know that there have been considerable difficulties experienced. That cannot be otherwise—difficulties to which Mr. Speakman makes very slight reference. We have, for instance, a comparison of the *Amethyst* and the *Topaze* —a comparison which has been very frequently made since the particulars were originally published in *Engineering* last year, which seems to show that in this particular case the reciprocating engine and the turbine give equal steam consumption at about 14 knots, which, no doubt, under the conditions of the trial, was perfectly true. Last year I got from the British Admiralty the figures for the low consumption trial of the *Oak*, which was made long before the comparison of the *Amethyst* and *Topaze*, the *Oak* being run under the most favorable conditions for low consumption, with one screw and one boiler. The *Amethyst*, of course, was run with a cruising turbine in use; that is to say, she was run under the most favorable conditions possible at low speed. Laying down the curve, the consumption of the *Amethyst* and the *Oak* were equal, not at 14 knots, but at 20 knots. At 14 knots the consumption of the *Amethyst* was about 100 percent higher than that of the *Oak*. Then again the *Victorian* and *Virginian* are referred to in the paper, but I think every one who has taken care to gather information about these two ships will not be inclined to believe that they have been an enormous success. In the new Cunarders we have been very clearly given to understand that there is no hope either of saving in weight or of saving in economy. And is it not true that these Cunarders have been increased very much in size in order to allow the turbines to be used? Is it not true further that work on the large Cunarders is being made to go very slow until the *Carmania* is out?

Admiral Melville and I have concluded that the turbine could be most successfully applied—could be applied only to fast steamers; and that there was great risk, as far as the economical results were concerned, in applying them to steamers of much less than 20 knots' speed. We concluded, however, that the turbine has a very large field. The reciprocating engine, however, unless there is some further development, has a very much larger field. The enormous bulk of the business is carried on in steamers a long way below 20 knots, and in that class of boat, so far as the turbine has been developed to-day, I do not think the turbine will be a success. To gain economy with the turbine we must have very high peripheral speed, which for a moderate diameter means very high revolutions. Now, for the efficiency of the propeller we must have a very moderate speed, and the two conditions come near one another only when the speed is high.

Mr Speakman presented a paper last month before the Engineers and Shipbuilders in Scotland, which in some respects is a good deal fuller than the paper we have in our hands. It would

be a very good idea if Mr. Speakman would fill up some of the gaps which, for certain reasons, he has seen fit to leave here. The details of turbine design which he has given us are very meager. The subjects of propulsive efficiency and propeller thrust are frequently referred to. The value of the propulsive efficiency is supposed to be known, or to be calculable with considerable accuracy for the various classes of work, in determining the proper dimensions of the propeller and turbine. To predict in a proposed design of a ship the value of the effective thrust within five percent, it seems to me, is practically impossible, and in the design of both the propeller and the turbine much larger errors would have to be allowed for.

If Mr. Speakman would give us the complete calculation for a particular case, both the calculations on which one could make the preliminary determination, and the exact calculations of pressures, efficiency, etc., with notes showing what is deduced from theory and what from his own experience and judgment, I think it would be very desirable. The turbine theory is much less perfect than that of the reciprocating engine, and there is much more in which judgment and data from particular cases count. This calculation would compress a large amount of information into a concise and handy form.

There is a great deal of data which has to do with the different sizes of circumferential clearances to allow for the warping of the port and rotor, perhaps a permanent warping due to the metal changing its shape after being machined—a question which has to be very carefully considered. There are radial clearances, and there are longitudinal clearances, which should be as great as possible, so long as the efficiency does not suffer. Then there are the clearances of the balance rings, and it would be very interesting to have information as to the percentage of loss due to the steam passing those rings.

President Bowles: As to the Staten Island ferry boats, it seems to me obvious that a machine consisting of a single drum on a continuous shaft, and containing within itself a number of wheels that would operate that boat at full speed in either direction and with equal efficiency by simply shutting off the steam from one end and turning it into the other, has obvious advantages over a vessel containing two complete triple-expansion engines with a number of moving parts. It has also appeared to me that control of such an apparatus for ferry-boat work has an obvious and enormous advantage. I can conceive that within an appreciably short time it will be possible to control such a turbine engine from the pilot house, and to place it absolutely under the control of the man at the wheel.

The turbine has enormous advantages in practical use entirely apart from the exact economy that can be obtained at the present time. Whether the economy is 10 percent less or 10 percent greater than that of the triple-expansion engine will hardly weigh with the practical advantages of the turbine for marine propulsion. For merchant vessels the very substantial gain that can be obtained in carrying capacity by the use of the turbine will far outweigh any of the questions of relative economy that are being brought up with regard to the use of fuel. You may not see now how that is going to be brought about, but it will be shown.

There are a number of collateral advantages in the use of the turbine. Its readiness for operation is an important one in many commercial services. That has been shown, and the results have been published, in the generator turbines in use in the work at Niagara. The troubles which infest boilers from the excessive use of lubricants will be vastly reduced. I believe that the labor and the attendance upon these engines will also be very considerably reduced over what is now customary in our regular steamers. When we come to warship construction the turbine assumes a different aspect. In securing high speed in war vessels, which now seems to be much emphasized in its importance, the question has largely resolved itself into securing the maximum supply of steam for a given weight, and now that the introduction of the turbine permits the efficient use of all the steam that can be generated, that should very much facilitate the increase in speed in larger vessels, without corresponding increase in weight. It will permit and encourage the introduction of oil fuel as a means of producing a greater quantity of steam with the same weight of boiler. In the same way it will encourage the introduction of the mechanical stoker for the same purpose. And, I believe, that as the result of these three elements, that is, oil fuel or mechanical stoking, the water-tube boiler, and the turbine, we are about to see a radical improvement in the types of war vessels.

Mr. Forbes: The silence which fell on this community when the chair offered the paper for discussion, I think, judging by my own feelings, arose from the fact that we felt as if we were assisting at our own funerals. But it seems to me that these papers are read to give us instruction—not merely to tell us where we can go and get something; and I earnestly hope that those who have had actual experience themselves will, in the further discussion, tell us a little about the troubles that they have, and the difficulties that they encounter in handling them.

Mr. Emmet: I have had a wide experience with turbines of the Curtis type. Some four or five years ago I became convinced of the practicability of this idea from certain results obtained on a very small experimental machine, which had not appealed forcibly to others who had inspected it. Upon the strength of my conviction I committed my employers to many millions of dollars of expenditure in developments based upon that idea. The carrying out of that work involved the construction of many hundreds of turbines, and we have had a great amount of experience with the practical problems involved, and also with the problems which relate to the turbine art generally. Our work is the application of turbines to the driving of electric generators, and it is essentially a high speed problem; but in the course of our experiments and developments the possibilities with other speeds have also been developed to a very great extent; and, furthermore, the mechanical problems and the construction possibilities have been developed to a very considerable degree, and we are, therefore, in a position to form ideas concerning what can be done. The turbine problem is one which involves a vastly greater number of variables than the problem involved in the application of steam engines to similar purposes, because turbines may be built in a greater variety of ways. The problem, therefore, presents theoretical complications with great mechanical simplicity.

The Curtis turbine involves certain practical features which all other turbines, in my opinion, have lacked. In the first place, it is a machine which operates without thrust. In the second place it is a machine in which clearance is a matter rather of indifference than of practical limits; and in the third place, it is a machine which can be built in very light weights, even where the diameter is extremely large. I may say further that it is a machine in which a very small number of parts can be used, as compared with the number of parts with other types of turbines. These matters are all of great importance, because they make possible the use of very cheap, simple and light constructions. In our electrical work, which is high speed work, our constructions are necessarily very strong, and there are great strains to be dealt with. In the marine problems these strains will not exist, and, consequently, a very much less expensive type of construction can be made practicable.

In the Parsons type of turbine the thrust must be balanced, and the balancing of this thrust must involve certain loss through clearances. The amount of clearance required will govern the economy in a sense, and the losses will vary if the adjustment varies. With the Curtis turbine no such limitation exists, because thrust is absent, except such thrust as comes from the propeller; and economy is independent of the actual clearance of the buckets within such limits as we need to consider. For this reason a test of certain buckets on a small wheel is an absolute guarantee of the performance of the same or similar buckets on a large wheel. In the Curtis turbine design you have a construction which can be made strong and stiff with a very light weight, and its cost will probably prove to be comparable rather with the cost of decks and hulls than with the engines.

We have had many serious troubles with turbines through various kinds of miscalculations and misunderstandings. Our first wheels were steel disks, and some of them under certain conditions of casting strains would buckle. When we began we did not know what our clearance should be, and we had trouble with wheels touching. We have since found ways of preventing the buckling of the wheels, and have found that we can increase our clearances on large machines without affecting the steam economy. We also had trouble with the governing mechanism; and the valves stuck. All those troubles, however, have been overcome, and among our last turbines are two in Boston, 5,000 kilowatt, which have been operating for a year, and there has never been with them a minute's trouble of a mechanical character. They are doing considerably better than the steam guarantees made upon them.

To properly apply the turbine is a great problem, a problem which will require engineering skill and daring, and if anybody thinks that he can get the product ready made and apply it to a ship without having practical difficulties he deceives himself.

Mr. Dickie: The previous speaker mentioned that all the parts of the rotor were balanced before they were put together, and that that was one of the difficulties in the rotor of the Parsons turbine. I saw one of those turbines being fitted up. It was taken apart quite a number of times and filed and chipped in order to get the rotor properly balanced, so that the center of gravity was on the axis of rotation.

In the Curtis turbine, has there been any difficulty with the rocking moments set up by the pitch of the vessel on any boat that has been tried? That is, where the rotor of the turbine in revolving pitches, with a motion forward and a rotary motion producing a condition which turns the turbine on its base? This was very carefully figured out by Prof. Gray on the Parsons turbine for the new large Cunarders, and it was found that the points of support are so far apart that the actual strain is negligible.

Mr. Winship: Can the turbine engine be made of suitable size to drive auxiliaries? A large turbine uses no lubrication and no oil. If we could use the turbine for the auxiliaries it would be a very good thing. If we can get it to run at from 800 to 1,000 revolutions the auxiliaries could be operated very nicely with turbine engines.

Mr. Crane: I have had some personal experience with the only turbine-driven vessel which has been in general use about the harbor of New York, and it has brought to light some difficulties which I think would make it inadvisable to use such vessels for general harbor use. The *Tarantula* has been in general service between Twenty-third street and Great Neck for the past two years. She has three propellers driven at 1,400 revolutions. Those propellers were very efficient when they were new, but when they had been in use for perhaps two or three weeks the edges became so badly deformed, owing to striking logs and driftwood, which are very common in the East River, that they had to be removed and replaced. During the past summer we have used six sets. Now that, it seems to me, for ferry use, would be rather disadvantageous, and I venture to say that the propeller problem is the greatest difficulty of the turbine.

Mr. Mosher: I replaced the boilers in the *Tarantula* after about two years' service. The old boilers were opened up, and we found considerable quantities of black deposit, and considerable indications of corrosion, and began to search for the cause. We had some of this deposit analyzed, which brought to light the usual causes with one addition—a considerable deposit of aluminum. The only source from which that aluminum could come is the blades of the turbine, which I understand are made of aluminum bronze. The percentage of aluminum was something over seven, and I would say that the water was the ordinary East River water. That would seem to indicate that there must be considerable deterioration of the blades of the turbine. As yet there has been no physical demonstration of it, but we expect during the winter to have an opportunity to examine the blades, when we may be able to present some additional information on the subject.

Mr. Curtis: I might add that the total power capacity delivered or under order is somewhere between 600,000 and 900,000 horsepower.

In the uses of the turbine on land the advantages in the machine do not show up materially until you get into sizes of considerable horsepower. We have not had enough experience in marine work to enable us to say at all from practical experience how low down you could go in power or in boat speed and get a result that on the whole would be as good or better than an engine. With a launch of moderate or slow speed, say of 12 or 15 horsepower, I question whether there would be any material advantage in the turbine, except the great simplicity of it. There is nothing to break down; there is a complete absence of parts; and nothing to get out of order. Our opinion is that that advantage is not enough to offset the disadvantage. In large vessels it is absolutely necessary to get a propulsive economy as good as the present engine, because the men who have to pay the coal bills will not listen to anything that entails an increased expense. But it is hard to say at present exactly how the turbine proposition is going to work out as regards economy. In some cases Mr. Parsons's boats seem to show an economy over the engines, while in other cases they do not seem to be as economical as the engines. Unfortunately, the practice of measuring shaft horsepower has not been introduced, and we really cannot tell anything about it. There is one interesting aspect of the use of the turbines, particularly our turbines, and that is the possibility of doing well at cruising speeds in naval work. This turbine is so designed and built that we can maintain the pressure distribution at different stages by closing the valves, and thereby we can get just as good an economy when running at slow speed as when running at high speed, barring the circumstance that the buckets are turning slower and therefore not as efficient.

There is quite a disadvantage in that in order to be able to run in both directions and do so economically you have practically to put two turbines on every shaft. These ferry boats require large screws. They must have a large starting capacity, and a large stopping capacity, and that means that you want low revolutions, and as they are rather low-speed boats anyhow, you have to have very large turbines on each shaft. Of course the reversing turbines in the case of an ordinary vessel do not require to be economical. As a matter of fact, by using two stages to reverse compared with seven stages to go ahead, we get a reversing power on the same steam consumption which is about 60 or 70 percent of what we get going ahead, and that is all right where you are only backing or stopping—reversing momentarily for the purpose of stopping the boat—but if half the time you are running in one direction and half the time in another, it is a different proposition. I do not think that the turbine offers a good solution of the ferry-boat proposition.

The wheels of our turbine being disks in form, there is no difficulty whatever in balancing them. It is not even necessary to balance the buckets or to balance the segments before they are put on. If they are simply bolted and attached to the wheels, and the wheels, as a whole, balanced, which can easily be done, we get a balance which is practically perfect for marine uses. In higher-speed work, such as the General Electric Company use, it is necessary to get a dynamic balance in most cases. That is, the wheel has to be spun to let it find its own axis, and if that does not agree with the physical axis of the wheel, it is marked, and the balance of the wheel is changed by adding weight to it on the other side. But practically there is no trouble in balancing.

In regard to the side thrust on the bearings, due to the shifting of the bearings changing the direction of the axis, which takes place when the ship pitches, we are without experience. I should say that the gyroscopic effect certainly would not more than double the side thrust on the bearings, and that would be of no consequence. Where the weight is large the revolutions are very much reduced and the rolling or pitching of the ship is

comparatively low; so that in a large ship it would not be so bad as in a small ship.

In regard to the deterioration of the propeller blades, our experience in the *Revolution*, which had somewhat smaller blades than the ordinary practice, was that we did not suffer from bending or cracking. I think twice in a year and a half the tip of one of the blades got bent a little, but we had no difficulty in straightening it when it was taken out. The boat was used around New York harbor all the time, and every now and then we would strike a log. It seems as if it would do a great deal of damage, but for some reason it does not. I should imagine that it is very easy to reach a limit in the thinness of the blade.

## HOW A NINETY-FOOTER BEHAVES IN AN OCEAN RACE.

BY PAUL EVE STEVENSON.

ABSTRACT.

Through the bad weather, whether running or lying to, the sea motion of the yawl *Ailsa*, which was with one exception the smallest vessel that took part in the great race for the Kaiser's Cup in May, 1905, was the most astonishing attribute of the boat. Instead of knocking the crew about, it was found that the rolling and pitching were so pliant and comfortable as to astound those who were prepared to encounter the worst moments in their experience. As a matter of fact, the rolling and angle of heel at their utmost could not approach that of a large sailing ship either running her easting down or hove to in the Southern Ocean. The height of the largest seas was perhaps from 40 to 45 feet from crest to trough but every one of them broke heavily with a curved edge from which it was very difficult to get away, and their sides or flanks were almost vertical.

Many yachtsmen speak of the yawl rig as the very essence of everything desirable for a sea-going vessel; in their eyes it seems to have almost preternatural gifts in heavy weather; when Herculean tasks abound there is nothing to compare with it. The truth about the yawl is that the rig breaks up the sail area and reduces it for racing purposes, and that it does not seem to be of any use at sea. If the jigger were carried when laid to, the boat would go all the way around on the other tack and create incredible confusion; and in moderate weather close hauled, a cutter will outpoint and outfoot any yawl of her size ever built.

## PROBLEMS IN CONNECTION WITH HIGH-SPEED LAUNCHES.

BY CLINTON H. CRANE, ASSOCIATE.

ABSTRACT.

The very recent development of the so-called "gasoline engine" of extremely light weight in proportion to its power has given the opportunity of making another step forward in the direction of great speed upon the water. Up to the present time gasoline engines of extremely light weight have been available only in powers up to 300 horsepower, and in the majority of cases of successful operation, in powers not exceeding 150 horsepower. In utilizing this new form of power the size of the boats has necessarily been small. In choosing a type of hull naval architects have had to avail themselves of what had already been done in steam.

The most serious objection to sharp bows and "tooth-pick" sterns, as they used to be called, is the loss of stability which this form involves. Apparently this loss of stability is much more serious and more noticeable at high speeds than at low. Whether this is due entirely to the increased torque of the propeller is a matter about which the writer is not yet entirely clear. This torque of the propeller in a fast single screw launch is a matter of serious consequence. In the case of the *Dixie*, running at full power, this torque amounts to placing a weight of 350 pounds at the gunwale, or about 8 percent of the boat's weight. In my opinion, for the best use we need a compromise between the extremely sharp and the extremely flat types. It is in arriving at this compromise that the naval architect can best show his skill.

DISCUSSION.

Mr. Cox: Mr. Crane said that in running the *Dixie* the rudder was a very useful factor in keeping her right side up at times, and that is a rather unusual thing. It is peculiar to think that it is possible to keep a boat right side up by the use of the rudder. Of course, this consideration is more academic than practical, but it brings up the fact that from a purely theoretical point of view the study of the stability of boats being driven as these boats are is extremely interesting. Possibly most of us were very greatly struck by the comparison of the *Napier II* and the *Dixie*. As pointed out, there was nearly 50 percent greater displacement in the *Napier II*, yet she succeeded in developing a very small fraction greater speed than the *Dixie*.

It seems to be demonstrated from the propeller experiments that have been given this year and last that the small diameter propellers are relatively more efficient than the large diameters. It seems that Mr. Crane has experienced cavitation, and has reduced its effect by cutting down his diameter of propeller and increasing the pitch. Now, if we can reduce cavitation by reducing the diameter of the propeller, it shows that we do not know all we ought to about cavitation.

Mr. Kemble: As regards the *Napier II*, I am under the impression that she was not entirely satisfactory as to speed when she first came out, and that last winter the afterbody was entirely rebuilt. I would like to ask what has been the extent of the use of the turtle back as against the use of freeboard? Also as to what speed of propeller has been found to avoid cavitation, if any particular speed, or whether that depended more on the pressure per square inch of thrust than on the speed of revolution of the tips of the blade?

In regard to the reaction of the propeller, in talking to one of the French naval officers who was over here last year, he told me that there was a noticable heel to the vessel when running at high speed in smooth water, with the two propellers running in the same direction.

In the Whitehead torpedo, where you get the maximum heeling effect, they have to put on two screws running in opposite directions, to keep the thing from simply spinning.

A member: Referring to the comparison between the *Dixie* and the *Napier II*, Mr. Yarrow has shown apparently that the form of the *Napier II* was easier driven, but on the other hand, it is much worse in a sea way. A point which I think is very interesting in the paper is that point of reference to the reaction of the screw. I have heard of only one other instance where this took place, namely in the case of a French racing cutter *Debonnaire*, about a 60-footer, with an engine of about 300 horsepower. Although the engine was designed to run at 700 revolutions, they were unable to get it up over 500, on account of this point. I would like to ask Mr. Crane if he has ever figured it in terms of the engine power or general terms of stability, instead of weight.

Mr. Stevens: It seems to me that the heel produced by the action of the propeller is, theoretically, a problem very easily solved; but practically when you come to apply it to a vessel you will find that the results depend almost entirely on the form of the hull, and on the conditions under which the propeller is working; so that it has been one of the subjects that has given the designers of small boats more trouble than almost any other.

Mr. Du Bosque: It seems to me that the upsetting motion of the boat is very small, or is simply the turning over of the crank by the friction of the thrust bearing. It doesn't require any action of the propeller whatever, because the thrust bearing is what is taking the twist moment.

Mr. Crane: The question has been raised about the *Napier II*. I know that she was not a success the first year. I have hearsay information that the reason was that she went heavier than she was designed to be, and that during the winter they changed the stern slightly to take care of the extra immersion, and after that

she was a success. I have never put a turtle back on with the idea of making a boat a better sea boat. I believe in carrying the prow up as far as is necessary. The turtle back is simply a court of last appeal. I have been on one of these boats driving into a heavy sea, and I have come very near driving the bow under entirely. It occurred to me it would be better to have a rounded turtleback to strike the water than a flat deck.

Cavitation is one of the things that "now you think you have it, and then you find you haven't." It seems logical enough to say that it is very easy to figure your pressure per square inch of projected surface under 11 pounds, and thus avoid cavitation. I have found that that is not so. The next thing that at once occurred to me was that cavitation must be due to the peripheral speed of the wheel. I had last winter the very anomalous case of getting cavitation with a 20-inch wheel, and replacing it with a 19-inch wheel, and not getting it. It seems to me that the shape of the blade itself, and especially the cross-section of the blade, has more to do with cavitation than has usually been believed.

The horsepower of these various motors is—unless you have actually seen a test—something that you cannot be very sure of. I think we can be reasonably certain that with the same size of cylinders and the same character of workmanship, and the same high class builder, your power is about the same. The *Dixie's* engine has never been indicated, and whether it develops 140 or 150 or 180 horsepower is a matter of taste. You can take which you choose.

The question of torque is not a new one. The single screw torpedo boats were all so troubled. The way I figure the torque is simply to resolve the brake horsepower of the engine, and that gives me a certain twisting moment. This boat happens to be five feet wide. If you multiply 2½ by 350 you get the moment of torque. That is not absolutely accurate, but it is probably as near to it as we can get. There seems no doubt in my mind, after the developments of this summer, that in those extremely high power boats you have got to use a stern which will statically resist heeling.

## PROGRESSIVE SPEED TRIALS OF THE GASOLINE LAUNCH LUDO.

BY GEORGE CROUSE COOK, MEMBER.

ABSTRACT.

The length of the hull between perpendiculars is 25 feet; maximum beam, 4 feet ½ inch; depth at half length, 2 feet 4 inches; draft of hull forward 1 foot 1¼ inch; the displacement on trial was 2,144 pounds. Six double runs were made, alternately against and with the tide, at revolutions averaging respectively 180, 296, 424, 452, 506 and 540 per minute, and with corresponding mean speeds of 6.67, 8.5, 11.44, 12.24, 14.01 and 15.33 miles per hour.

A prominent feature of the figures and the curve of speed-revolutions is the slow increase of speed for increased revolutions at low speeds, and the rapid increase of speed for comparatively slight increase of revolutions at the higher speeds. This feature, so at variance with that usually observed in ordinary work, together with the shortcomings of the rule for estimating the horsepower-revolutions, leads to odd developments in the speed coefficient curve based on the Admiralty formula. In this latter curve there is a marked increase of the coefficient for the higher speeds, and, in fact, it reaches a maximum, showing maximum efficiency, at the top speed.

## SCANTLING REGULATION IN YACHTING.

BY W. P. STEPHENS, ASSOCIATE.

ABSTRACT.

It is only about 1880 that we find the first indications of the principle which is accepted to-day as the proper basis of all measurement legislation: the accurate appraisement in a formula of a number of the elements of speed, size and power, leaving it to the skill and judgment of each designer to select each in a certain proportion so long as the total be within the limit of the class in question. Two vital principles of successful legislation are that yacht racing can flourish only when the tendency to extreme over-development is restrained by suitable rules; and that a measurement rule to be effective must be based upon some approximately accurate valuation of the largest number of factors which may be handled without too much complication.

The first attempts at the regulation of construction date back about twenty years, being coincident with the establishment of the now popular one-design or monotype classes. It must be recognized that beyond a certain point light construction in yachting is purely an economic and not a technical problem. Backed by adequate scantling restrictions, even an indifferent rule may work well in practice; but it is evident that no rule, however perfect, can meet the desired end of promoting a wholesome type of all-round racing yacht unless it be reinforced by some regulation of construction.

## METHODS OF CONDUCTING SPEED TRIALS.

BY NAVAL CONSTRUCTOR J. J. WOODWARD, U.S.N., MEMBER.

ABSTRACT.

The determination of the true speed of a vessel through the water is one of those numerous problems for which we have only approximate and not exact solutions. The indications of the patent log are subject to sudden fluctuations of unknown amounts owing to changes in its internal friction; on the other hand, the ship's propeller, considered as a speed recorder, is affected only slightly by changes in internal friction of the machinery, and will give accurate comparative results, *provided* external conditions which affect the economy of propulsion remain the same. That is, if the displacement, condition of the bottom, effect of the wind upon the vessel, etc., remain the same, then the number of revolutions of the ship's propeller permits an accurate determination of speed, provided we know exactly what speed has been developed over a measured base under exactly similar conditions. Without such similarity of external conditions, speeds based upon the revolutions of the ship's propeller are entirely fallacious.

In determining the speed of a vessel during any of the contract trials, the double run over a long measured course at sea can give reliable results only in a tideless sea. When tidal currents do exist the errors introduced by the attempt to measure the current are of the same order of importance as the effect of the current itself. When the results of the standardization trial are applied to the observations made on a four-hour run at sea, an error is introduced into the speed so obtained, owing to the difference in the state of the wind and sea at the times the two trials are held. The resulting error is, however, as slight in amount as such a variation in the external conditions must necessarily cause with any method of trial.

The beacons for a measured base line should have a base of ample size so that they can be immediately located from the ship by the unaided eye. Each pole should be surmounted by a small pyramidal shape to assist in distinguishing it at a distance. The images of the poles of the front and back beacons should transit across each other, as viewed from the ship when crossing the range.

DISCUSSION.

Mr. Stevens: Taking up the detail of trial trips, I do not see any safeguard mentioned for insuring accuracy in the trial. In several instances I have found runs which when reduced fail to plot with the other spots. I also fail to notice any reference to slack water, which I have found a very disturbing element in getting accurate results. Of course, we will all admit that the important point for the shipbuilder, under the contract for speed, is the high speed point. Perhaps the next point in importance in the curve is the low speed point. The unfortunate part is that that point is not really low enough to allow of making a close estimate of the internal friction of the engine by well known methods, and, of course, at that low point the question of speed is not of very vital importance, unless it comes into propeller

design. The main question there becomes one of accurate observations of revolutions and M. E. P. I have also at those two extreme points—the very high and the very low—found trouble in trial trips in knowing that I was getting a steady revolution of the engine. Many things will happen on board a vessel that we do not notice in the engine room in taking cards, that considably disturb the relation between the revolutions and the M. E. P. of the cylinders. I have found that I can detect in the engine room, by using a magneto at the shaft with an ordinary voltmeter, a very slight motion of the steering wheel. One other question is the importance of progressive trials, not only to the designer, but to the owner and operator. Boats have been operated for years with propellers of very great inefficiency, which were requiring much more work for given speed, and consequently a much larger coal bill than was necessary to get the results.

Mr. Bowles: Why is it that the navy takes such a fierce interest in what these vessels can do while they are in the contractors' hands, and then continues to have these vessels in their own hands until they are worn out, without doing any of these things? I believe that the contract trials of any vessel should justly and properly be made as simple as will prove that the ship is what it was intended to be, and that there should be no unnecessary elaboration or expense or delay involved in it. At the same time, I believe it to be best for all concerned that at some time in that vessel's history there should be a thorough and complete trial. I do not believe, however, that it should be made at the expense of the contractor. The present method of conducting contract trials is undoubtedly inadequate from any point of view; that is, the result to be obtained is simply one of speed. The consequence is that there is little field for engineering ambition—to put it broadly—in a trial of that kind. It is a narrowing development, and no doubt it should be somewhat changed. One of the serious things which have been brought out recently, as the cost and complexity and size of naval vessels increase, is that it is an unwise risk on the part of the owner to take out a vessel costing seven million dollars in the hands of a scratch crew, and probably would not be considered for a moment by any owner other than the government. I believe that all contract trials for naval vessels should be conducted with a United States naval crew on board. It would be good for the crew and it would be decent to the contractor.

Professor Peabody: This is a good opportunity for urging the great value of well made progressive speed trials for the naval architect who has in hand the powering of a new ship; and in particular, we may ask of what avail are the elaborate scientific investigations of our model basin if there are not afforded ample opportunitites of comparison of tests on models with tests on full-sized ships. True, the contractor should not be forced to pay for scientific information for the good of the government; but we have the suggestion that all trials be made at government expense, and trials sufficient for standardization of screws need but little amplification to cover the entire investigation desired.

The irregularities and inconsistencies of tidal current measurements are to me most startling, and while it may be that service conditions preclude any hope of improvement, I find it difficult to believe that more regular and consistent results are not attainable, provided that a study of the subject be undertaken by skilled observers. Part of the difficulty is, without doubt, chargeable to the real irregularity of the currents, for it is well known that eddies and undulations once impressed on a current persist a long distance. It may be noted that the ship averages the total influence both by her size and her progress. The great importance of properly marked ranges and desirable conditions for speed trials has been impressed on my mind by a varying experience of running such trials under all kinds of conditions, usually unfavorable on account of the necessity of taking the boats and ships tested when they could be borrowed.

For the present purpose, the determination of power is of secondary importance; but in the general subject of speed trials it is, to my mind, the most important for a naval architect, for upon proper power determinations depend his future success in powering ships. All the other errors of power and speed tests when conditions are at all favorable sink into insignificance when compared with the error and uncertainty of the determination of the power, because we are compelled to depend on the indicator, which at best is but a coarse instrument, and which is liable to fail us altogether if conditions are unfavorable. Now, of all the errors of the ordinary indicator with enclosed spring, when skillfully used, the worst is that due to the change of temperature of the spring. Outside spring indicators should, in my opinion, be used for all important work. At least three diagrams should be taken on the course. I am very suspicious of the stop watch, and favor the use of a chronograph, which may be a comparatively simple and inexpensive instrument, since we have no occasion for astronomical accuracy.

Mr. Hyde: Our company has been consistently in favor of the standardization method of trial. The contract practically provides that the contractor is judged by his performance on trial. It is therefore vital to him that the speed be as great as possible. We have always believed that standardization trials mean greater accuracy. It is true that this trial is more expensive to the contractor, but to me it seems that the greater accuracy is worth the difference in cost. There are also other advantages—if anything arises after the standardization trial so that it is necessary for the vessel to be returned to the contractor, it is not necessary for them to go over a measured course at a long distance. They can run it at some convenient point near their own works.

Mr. Weatherby: I cannot see the value of taking indicator cards on the progressive trial. Under those circumstances the man who is taking the indicator cards is limited in the time in which he can perform this operation to the time during which the ship is on the mile, and frequently it is hard to obtain good cards. I think that the proper way to obtain the power curve is to run the ship in the open sea, keeping her on a steady course, with the wind and sea abeam. Then the man who is taking the indicator cards can give his instructions to the chief of the engine room, stating that he wants so many revolutions. When he has a sufficient number of suitable cards he can give an order to have some other number of revolutions. In that way you are sure of accurate indicator cards.

I believe that the high runs of the standardization trial should be made at the end of the trial; for it is necessary to steam at least an hour and a half after leaving anchorage before the ship is in condition for the high run. That gradual warming up might just as well take place over the measured mile as to be used up in cruising around, and by so doing, after the ship has been under steam from two to three hours, you are in position for your high-speed runs.

Mr. Woodward: On all trials as at present conducted, we have not only two buoys marking the points where the ship should cross the range, but there are in addition two approach buoys, so that when the ship is a mile from the point where the speed is to be measured the officer directing the course of the vessel has as a guide, on a bright day, when he can see the furthest buoy, four buoys, but always two in line, so that he gets his ship pointed in the proper direction, and carries the ship through exactly the same condition of depth of water. The matter of having a ship given the proper heading is very important because of the effect of small angles of helm. There is a tendency for the man who steers the ship to use the helm when he doesn't need to, if he would only remember that the one point involved is to steer the vessel on a compass course and not on a straight course through the water, with any set of the tide across the course.

From such observations as I have made, although sometimes the period of slack water is very undesirable, at other times the rate of change of the current is not as irregular at slack water as one would anticipate. In any event, the main point to be con-

sidered is that if we are going to use for the determination of contract speed of large vessels any course, there should be a thorough investigation as to the general character of the tidal currents on that course; an investigation lasting over one lunar month, and perhaps more, in order to get the best general information as to the tidal currents, and in addition, preceding any important trial, the observations of the current should be taken by a vessel the day before the trial begins, so that although our current measurements do not give us any real quantity, and although we use those records in no manner in the trial, still we have this information available, and it permits us to avoid the irregularity in the current.

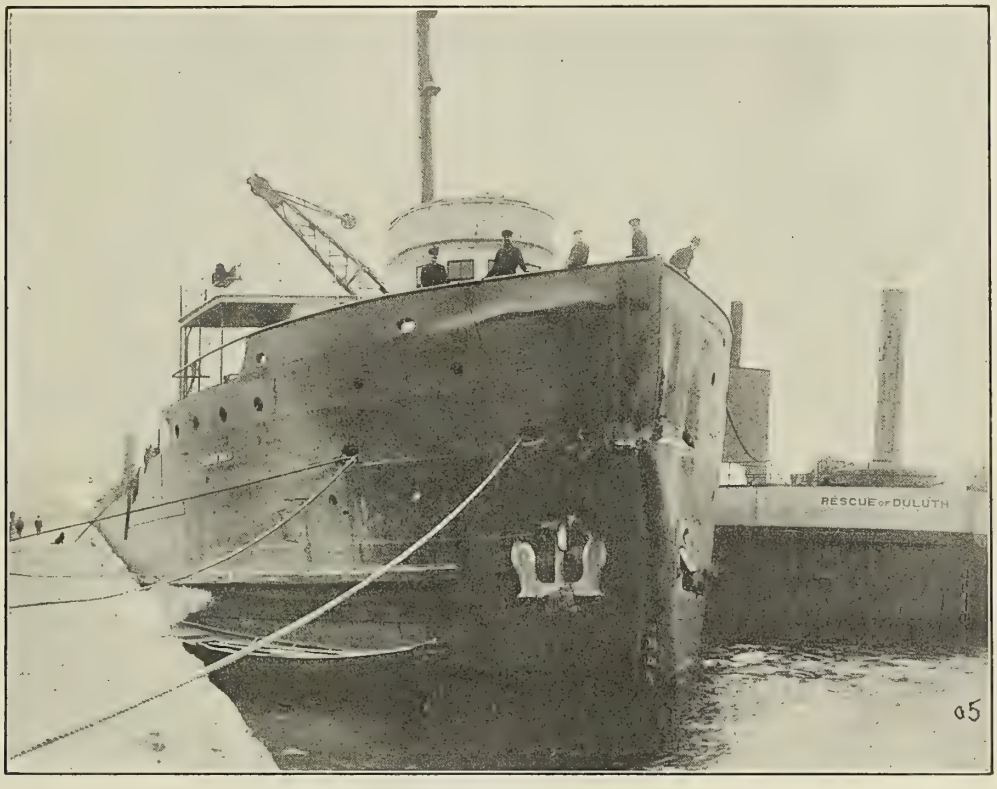
It is perfectly true that we are somewhat unique, I think, in making our contract requirements exclusively determined by speed; but anyone who has gone into the conditions will admit that there is less chance for conflict of interests, and generally that the determination of the observer by measuring speed, although by no means ideal, is much more reasonably accurate than the determination of horsepower, as a matter of insuring excellency to a certain degree. I think that if we had to apply penalties on horsepower there would be much more chance for difference of opinion than on speed.

In regard to the matter of making the high runs at the end of the trial or at the beginning of the trial, I think that is usually a question that depends on the thoroughness of drill and organization of the ship's company charged with the conduct of the machinery. There is a certain nervous tension on the part of an engineer who is responsible for operating this large machinery at a particular speed, when responsible to his employers for conducting the trial in such a way that it will not have to be repeated.

At a business meeting of the Society amendments to the constitution as proposed last year were adopted. The most radical change deals with the election of officers, and provides that the president shall serve for three years, and shall not be eligible to succeed himself. The vice-presidents will serve six years, and members of council three years. In both these latter classes arrangement is made whereby definite numbers of the terms of office end every year, so that by new elections the list is kept filled without any possibility of getting in an entire new and untried board. It is the same idea as that provided for filling seats in the Senate of the United States.

On the evening of Friday, November 17, the usual banquet took place at Delmonico's; the Society was addressed by a number of gentlemen, prominent among whom were Senator Jacob H. Gallinger, of New Hampshire, Chairman of the Merchant Marine Commission, and Rear Admiral Robley D. Evans, Commander of the North Atlantic Squadron.

On Saturday a large number of members and guests visited the works of the General Electric Company, at Schenectady, through courteous invitation of the company, and were afforded exceptional opportunities for a full inspection of the plant.




THE HARVARD, AFTER COLLISION WITH THE THOMAS W. PALMER.

### The Sinking of the Steamship Palmer on Lake Superior.

In a dense fog some fifty miles east of Copper harbor, the steamer *Thomas W. Palmer* was in collision May 16 with the steamer *Harvard*, and was sunk. The *Palmer* measured 281 feet in length, 41 feet beam, and 20 feet in depth, with a gross tonnage of 2,131. She was loaded with coal and was almost cut in two.

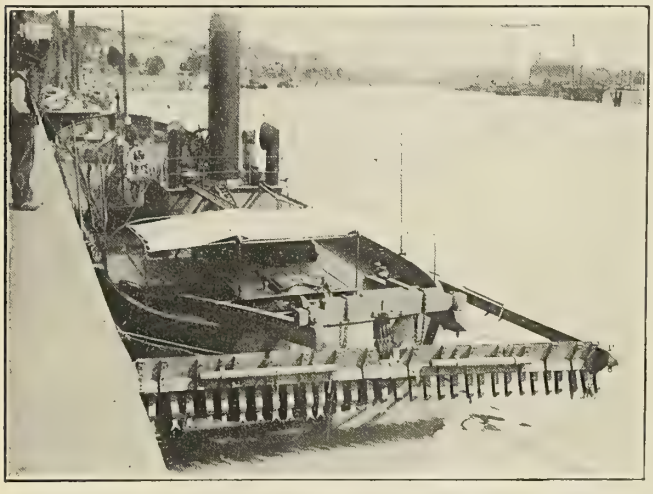
The *Harvard*, which sustained the damage shown in the accompanying photograph, is a steel freighter 461 feet long, 50 feet 2 inches beam, and 29 feet in depth, with a gross tonnage of 5,054. She was loaded with iron ore. Repairs to the *Harvard* were made by the American Shipbuilding Company at Cleveland.

### The Raking of a River.

The river Loire has sandy banks which cause a great deal of trouble at the time of the regular winter overflow by filling up the channel and entirely altering the course of deep water. It is thus necessary to keep continually dredging the river for a distance of about ten miles, over which the obstructions are met. The depth is kept at such a figure that ships of 18-feet draft can reach Nantes at any time, while at the highest tides ships of as much as 23 feet in draft can use the channel. One of the schemes for taking care of the considerable quantity of mud and débris which gets into the channel is indicated by means of the accompanying

THE RAKING DREDGE AT WORK.

photograph, showing a peculiar dredge with a rake attachment at the stern. This craft has a length of 131 feet, a beam of 23 feet, and a registered tonnage of 292, with machinery of 300 horsepower.



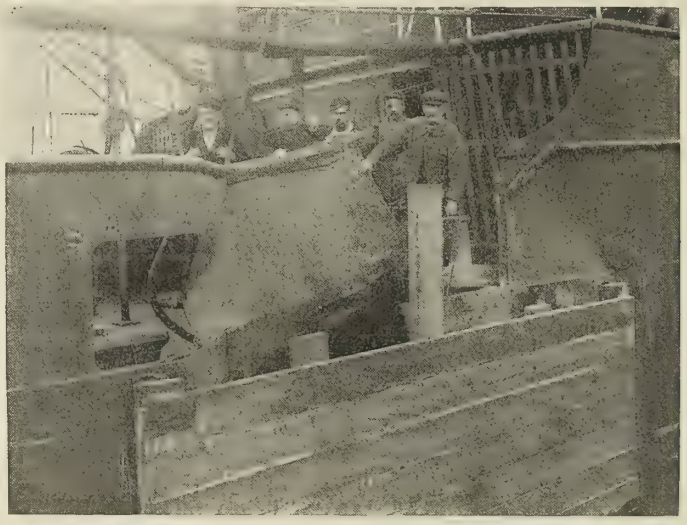
THE RAKING DEVICE RAISED FOR INSPECTION.

The rake has a length of 36 feet and a weight of 2.5 tons. During the ebb tide the steamer goes to the middle of the river and drops the rake, and then runs from Nantes to the entrance of the channel and back again until the next high water, by which time the rake has succeeded in so mixing up the mud with the water as to render it fluid. It is then carried out to sea by the tide going out.

### The Minister Tak in Collision.

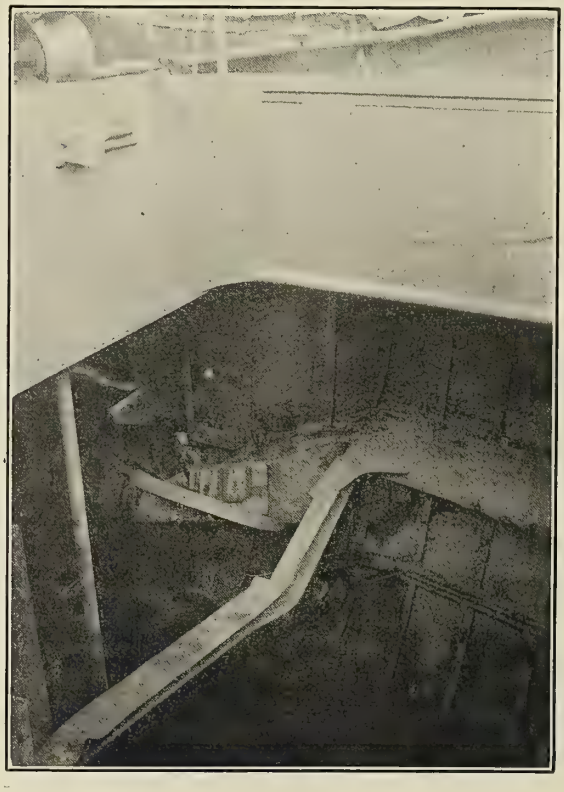
Early in September the steamship *Minister Tak* left Hull for Harlinger with a cargo of bales, and on nearing Grimsby she was run into on the starboard side by the steamship *Falka*, which was not seriously damaged. The *Minister Tak*, however, was badly injured under the water-line, and leaked very rapidly. She was beached on a mud bank near Grimsby, was patched up there temporarily with wood, and towed back to Hull, where the extent of the accident was ascertained, and she was placed in dry dock. The bulwark plating and main-deck stringer plate were badly broken, and there was a large hole in the main-deck sheer strake, this hole extending down the side of the ship to the bottom plating. One hold stringer was badly broken and a strong hold beam much twisted and broken.

The *Minister Tak* is a steel screw steamer measuring 205 feet 7 inches in length, 29 feet 2 inches in beam, and 14 feet 5 inches in depth. Her gross tonnage is 747 and net tonnage 380. She was built at Newcastle in 1891 by Messrs. W. Dobson & Sons. She is propelled by triple-expansion engines with cylinders measuring 19, 31, and 51 inches in diameter.



TEMPORARY REPAIRS ON THE MINISTER TAK.

The *Falka* is a steel screw steamer measuring 260 feet by 36 feet 7 inches by 18 feet 2 inches, and having a tonnage of 1,107 net and 1,744 gross. She was built in 1889 by W. Gray and Company, Limited, West Hartlepool, and is propelled by a triple-expansion engine with cylinders 19, 30½, and 51 inches in diameter and a common stroke of 36 inches.



DAMAGE TO HOLD BEAM IN MINISTER TAK.

**The National Motor Boat and Sportsmen's Show** in Madison Square Garden will be held this winter from February 20 to March 8 inclusive. There is great pressure for space, the applicants including nearly all of the old exhibitors and many new ones.

## Superheated Steam Tests on Steamer James C. Wallace.

The subject of superheated steam has been so prominently before the engineering world of late that comparative tests showing the economy to be expected in the generation of power due to the installation of superheaters are of special interest and value. We give below the results of tests made during the past summer on the steamship *James C. Wallace.* This vessel is one of the largest of the modern ore carriers on the Great Lakes, being 552 feet in length over all, 56 feet beam, and 31 feet in depth, and during the trials described below she carried 10,400 tons of iron ore on a mean draft of 19 feet 4½ inches.

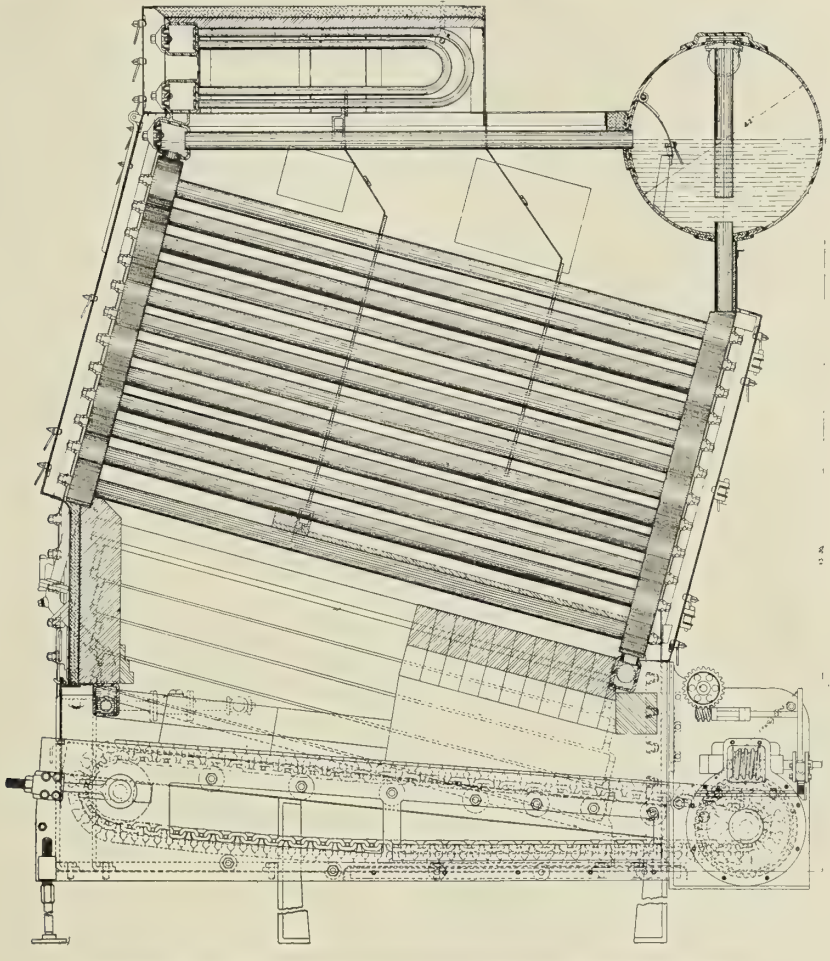
The machinery equipment includes one quadruple-expansion engine built by the American Shipbuilding Company, having cylinders 18½, 28½ 43½, and 66 inches in diameter, with a common stroke of 42 inches. Steam is supplied by two Babcock and Wilcox marine boilers, each having a heating surface of 2,900 square feet, and designed to carry a steam pressure of 250 pounds per square inch. Two stokers, built by the Duluth Stoker Company, are installed under each boiler, and a system of fan blowers is installed in the uptakes, so arranged as to provide induced draft at such times when natural draft is not sufficient to give the necessary data.

With these boilers, installed as part of the boiler equipment, there are two superheaters, one fitted to each boiler, each containing 414 square feet of heating surface. The steam, after being generated in the boilers, passes through these superheaters, where it is superheated approximately 90 degrees Fahrenheit, after which it passes directly to the engine and to the auxiliary machinery, all of the latter being operated separately and detached from the main engine. The piping is so arranged as to permit of the superheaters being by-passed and saturated steam being sent directly to the engine, the idea being to leave the ordinary saturated steam connections intact and make the superheater installation entirely separate and independent. This arrangement provides a ready method for changing the plant from one using superheated steam to one using saturated steam, the only changes required being the removal of one baffle plate and insertion of tiling under the superheater in such a way as to prevent all gases from entering the superheater, thus cutting it entirely out of service.

The fuel used was Pittsburg slack, having a heating value, as shown by calorimeter tests, of about 13,500 B.T.U. per pound of dry coal.

SUMMARY OF TESTS.

| | Test I. | Test II. | Test III. | Test IV. |
|---|---|---|---|---|
| Duration, hours | 8 | 6 | 8 | 6 |
| Degrees of superheat: At boilers | 86.9 | 92.1 | 0 | 0 |
| At engine | 81.7 | 88.0 | 0 | 0 |
| Steam pressures, gauge: At boilers | 237.6 | 241.2 | 237.3 | 238.7 |
| At engine | 233.7 | 240.4 | 234.6 | 237.8 |
| At first receiver | 94.2 | 95.4 | 101.2 | 90.2 |
| At second receiver | 34.1 | 34.3 | 38. | 33.5 |
| At third receiver | 9.96 | 9.74 | 11.63 | 10.12 |
| Vacuum, inches | 24.5 | 24.9 | 24.6 | 24.6 |
| Revolutions per minute | 79 | 79.6 | 80.3 | 77 |
| Cut off in cyls., fraction of stroke: | | | | |
| H. P. cylinder | .574 | .574 | .574 | .504 |
| First I. P. cylinder | .659 | .659 | .647 | .698 |
| Second I. P. cylinder | .598 | .598 | .606 | .64 |
| L. P. cylinder | .605 | .605 | .556 | .58 |
| Mean effective pressures: H. P. | 90.36 | 91.2 | 85.9 | 82.77 |
| First I. P. | 36.39 | 35.7 | 40.87 | 36.37 |
| Second I. P. | 16.06 | 16.78 | 18.44 | 17.27 |
| L. P. | 6.84 | 6.98 | 8.08 | 7.16 |
| Indicated horsepower: H. P. | 389.7 | 397.1 | 377.8 | 348.6 |
| First I. P. | 381.9 | 377.5 | 437.3 | 371.1 |
| Second I. P. | 396.7 | 413.1 | 461.6 | 412.5 |
| L. P. | 390.9 | 401.9 | 463.8 | 398.3 |
| Total | 1,559.2 | 1,589.6 | 1,740.5 | 1,530.5 |
| Coal: Moisture, in percent | 3.38 | 2.89 | 3.07 | 2.88 |
| Per hour, as fired, lbs. | 2,362.5 | 2,616.7 | 3,137.5 | 2,700 |
| Per hour, per I. H. P. (moist), lbs. | 1.515 | 1.646 | 1.803 | 1.764 |
| **Per hour, per I. H. P. (dry), lbs.** | **1.464** | **1.598** | **1.747** | **1.713** |
| Per hour, per sq. ft. grate (moist). lbs. | 15.96 | 17.68 | 21.2 | 18.24 |
| Percent of ashes in coal | 19.87 | 15.32 | 17.8 | 14.4 |
| Kind of draft | Natural. | Induced. | Natural. | Natural |
| Draft (ins. water), base of smokepipe | .22 | .42 | .24 | .22 |
| Temp. at base of smokepipe, deg. F | 485.3 | 499.6 | 557.1 | 553.5 |



BOILER OF JAMES C. WALLACE, WITH SUPERHEATER AND AUTOMATIC STOKER.

The first test was made with superheated steam, the engines being operated under the usual conditions, the cut-off in the high-pressure cylinder being 57 percent of the stroke. This resulted in 79 revolutions per minute and a total indicated horsepower of about 1,560. The superheat at the boilers was 87 degrees and at the engine throttle 82 degrees. The dry coal per indicated horsepower on the main engine, including the coal used in supplying steam for all the auxiliary machinery, amounted to 1.464 pounds.

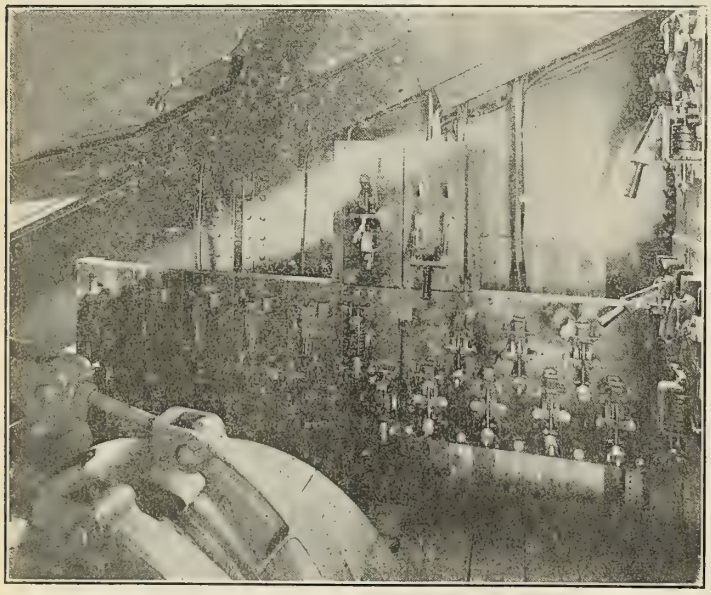
The second test was also made with superheated steam and all conditions remained the same, except that the induced-draft fans were in operation. In this test the superheat was a few degrees higher, being 92 degrees at the boilers and 88 degrees at the throttle, but the extra steam used by the fans, in addition to less economical furnace conditions due to excess of air through the fires, increased the coal per indicated horsepower to 1.598 pounds per hour.

The connections were then changed, so that saturated steam was sent to the engines and auxiliaries, and a third test was made under exactly the same conditions as test No. 1; that is, the cut-off in the high-pressure cylinder remained at 57 percent of the stroke, and the induced-draft fans were not in operation, natural draft being used.

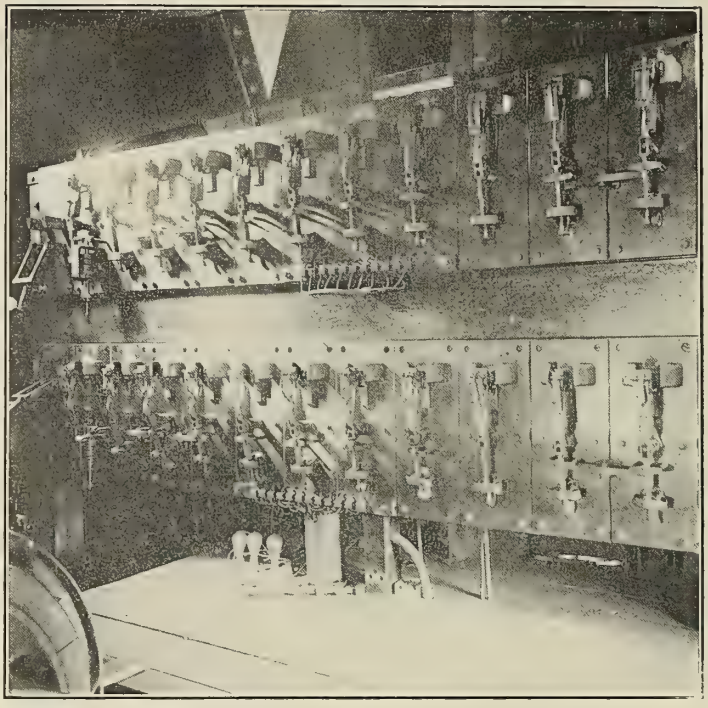
The first and last tests are the best for comparative purposes, showing the saving due to superheated steam when developing the same power. The dry coal per indicated horsepower in the last test amounted to 1.713, which, when compared with the test with superheated steam, shows a net saving in fuel under superheated steam of 14.5 percent. In other words, the installation of superheaters in this ship has produced a net saving of one-seventh of the fuel, all other conditions remaining the same, the same power being developed, and the same speed of vessel maintained, which in this instance averaged nearly 12 miles per hour. When it is considered that this represents a direct saving in the coal bill, it is evident that the use of superheaters is productive of one of the greatest economies which has been effected in steam generation in many years.

## HULETT ORE UNLOADERS AT LORAIN.

One of the most interesting and notable examples of the remarkable advance in modern industrial appliances is that to be found in the ore-unloading equipment of the great lakes. The ore-unloading facilities of the great lakes are far in advance of those in any other part of the world, and at not even the largest ocean ports is reached the marvelous speed of unloading and handling which has been obtained at the lake docks. A notable type of the modern equipment employed for the purpose—in fact, the one holding the world's record for fast ore unloading—is the Hulett automatic ore unloader, built by the Wellman-Seaver-Morgan Company, Cleveland, O.



MAGNETIC CONTROLLER FOR OPERATION OF GRAB BUCKET.



MAGNETIC CONTROLLERS FOR HOIST AND TROLLEY TRAVEL.

The general view herewith shows the latest installation of these unloaders: namely, two electrically-operated machines at the United States Steel Corporation National Tube Company's docks, Lorain, O. An idea of the heavy service required of these machines may be gathered from the fact that they rapidly handle an enormous grab bucket, which, when open, has a spread of over 18 feet, and which automatically digs and conveys from the hatches of the boat ten gross tons of iron ore at a load. This bucket, when open, can by telescopic motion be extended still farther, so as to reach more than half-way from the center of hatch to hatch. It is carried at the lower end of a vertical dependent leg suspended from a long pivoted walking beam, which is carried on a carriage or trolley traveling back and forth on the girders of the machine. The operator who controls all the motions of the bucket rides at the lower end of the leg directly above the bucket. By means of hoisting mechanism the walking beam is made to oscillate up and down, carrying the bucket down into the hold of the boat and up again above the dock. The leg carrying the bucket is mounted on rotating trunnions in the walking beam, so that it can rotate in a circle when operating in the hold of the vessel, permitting the bucket to reach out in all directions. It also travels lengthwise of the hatch to the sides of the boat; consequently the operator is able to reach almost the entire cargo. The travel of the trolley back and forth on the girders carries the walking beam with the bucket out over the boat and back over the dock. To reduce the trolley travel as much as possible, suitable hoppers for receiving the contents of the bucket are mounted between the girders at the front; these hoppers discharge into an auxiliary bucket car.

The Hulett unloaders at Lorain are provided with special cantilever extensions, designed particularly for delivering the ore on a high bank back of the machines. The bucket car travels on these cantilever extensions, automatically dumping the ore at any desired point, and returning closed to its position under the hopper. The entire machine is mounted on moving trucks, enabling it to travel up and down the dock from hatch to hatch without moving the boat.

The controlling devices for machines of this type are in all cases specially constructed to meet the conditions. The controllers,

proper, for this unloader, consist of a number of magnetically-operated clapper switches, which cut resistance in and out of the motor circuits. The switches are operated by solenoids placed on the back of the switch panel. The main contact of each switch is a heavy laminated copper brush, reinforced with a yellow brass contact, the final break being taken between carbon contacts, and the arc is quickly ruptured by a powerful magnetic blow out. The switches are controlled by small master switches located in the operators' cabs. As the solenoids of the switches require but few amperes, the wires connecting the master switches with the controller proper are of very small size.

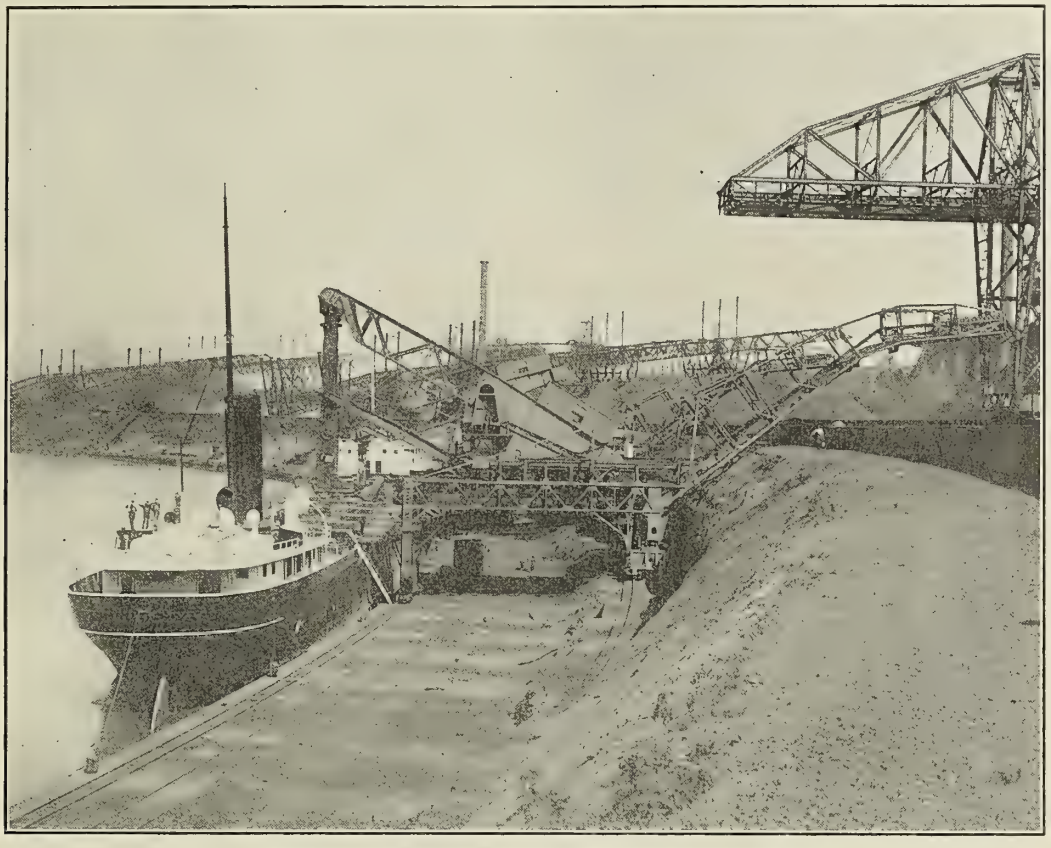
Each motion of the unloaders is provided with a positively connected or geared automatic cut out or emergency switch. The cut outs on the hoist and bucket-car motions automatically slow down and stop these motions as the limits of travel are reached. They first operate to gradually introduce resistance and slow down the motor; then change connections to convert the motor into a generator, and apply a gradual dynamic breaking effect, until the motion is nearly stopped, and finally apply band brakes. The application of dynamic braking to the above-mentioned motions is of particular advantage, as the energy of these heavy parts is absorbed and dissipated in the resistance, thus removing practically all wear from the solenoid band brakes. Under these conditions the band brakes operate as holding brakes, and are required to stop the motion only upon failure of current supply.

The bucket rotation and trolley motions are supplied with geared automatic slow down and cut out devices, which gradually insert the resistance, and finally apply solenoid band brakes to stop the motion as the limits of travel are approached.

While all of these automatic devices fully protect the machinery and motors against failure of current supply, confusion, and faults of the operator, still they allow the operator full control of the motors at all times, except that he is unable to pass a predetermined limit of travel of the motions.

The main controllers are located as near to their respective motors as possible, so that the heavy wires carrying large currents are made as short as possible. The master switches or controllers are small, thus allowing such an arrangement that all operating handles are brought within easy reach. They are very easily worked and do not fatigue the operator, thus allowing full output of the machines at all times irrespective of the physical condition of the operator.

The magnetic controllers, which control the movement of the bucket in and out of the boat, and the raising and lowering of this bucket, are shown. To the left there are seen four pairs of two switches each, interconnected by means of horizontal levers. These are the reversing switches, and the function of the levers is to absolutely prevent the closing of both reversing switches at the same time. To the right are seen two switches interconnected by means of two levers. The functions of these levers is to prevent the closure of the middle or dynamic breaking switch when the motor is still connected to the line and operating as a motor. The levers are also used to hold open the switches at either side of the center switch when the motor is acting as a generator with the center switch closed.

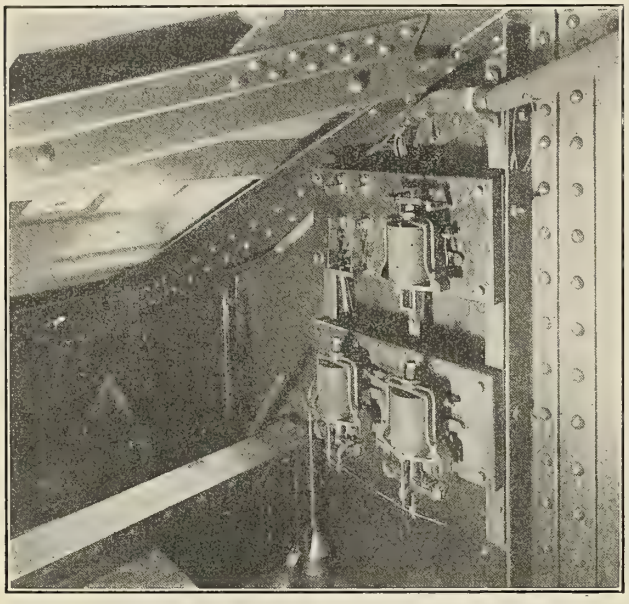


HULETT UNLOADERS ON DOCKS OF LORAIN STEEL COMPANY.

Another photograph shows the magnetic switch controller for the operation of the grab or clam-shell bucket. The smaller switches, at the left, are the accelerating or resistance switches. These switches are so connected that each succeeding one depends for its closure upon that of the one preceding. One terminal of the operating solenoid of each switch is connected to such a point on the resistance that the current, taken by the motor upon the closing of the preceding switch, must fall to a certain predetermined value before the following switch can close. This means that the motor must come up to a speed corresponding to each accelerating switch before the following switch will close. This results in the smoothest possible acceleration in the shortest possible time consistent with safety to motor and driving mechanism, and makes acceleration of the motor entirely independent of the operator should he throw the master switch with extreme rapidity.

The result of this design is to cause the motor to approximate almost exactly the operation of a hydraulic or steam cylinder; that is, it will keep a predetermined pressure on the

bucket jaws and will not exceed this pressure. The motor is generally stalled once during every closure of the bucket, and this occurs without injury to the motor, controller, or attached mechanism.



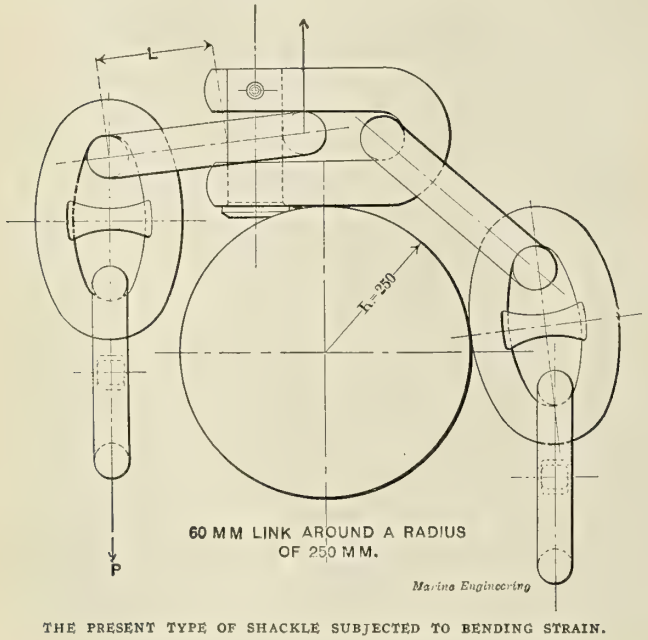
MAGNETIC CONTROLLER FOR BUCKET ROTATION MOTOR.

The master controller for operating the bucket rotation motor is shown in another view. This motion operates so easily that the controller is small and requires but few steps.

## CHAIN CABLE JOINING SHACKLE.

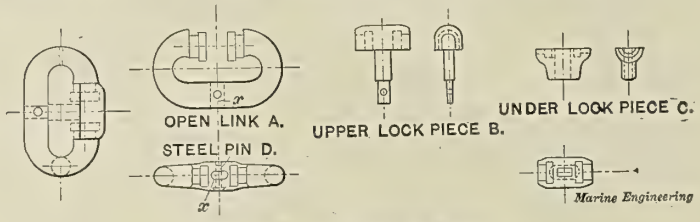
BY A. VOLLBRANDT.

In connection with the continual endeavors to increase the safety of ships, particular care has been taken to improve their anchor arrangements. Many propositions have been made with regard to the improvement of the existing chain cable joining shackles, from the ordinary construction of which very frequent chain fractures result. It is generally known that the chain cable shackle everywhere in use, as illustrated, is employed for joining lengths of chain with a single chain. It is, however, considered as extremely disadvantageous, for the following reasons:




THE PRESENT TYPE OF SHACKLE SUBJECTED TO BENDING STRAIN.

In the first place, the shackle cannot be used, in its present shape, for joining two chain cables composed of stud links. This is not only on account of the large dimension of the eye, in which the bolt is fixed, but also on account of the abnormal size of the shackle bolt. One is forced, therefore, to fit both ends of each length of chain with a long link and a middle-sized link, in order to be able to join the chain with the shackle. It results that only complete lengths of chain can be joined on board, and that the fracture of even a single link forces one to replace the whole length of chain. Thus we not only increase the manufacturing difficulties, but also find it a necessity to have spare lengths of chain on board, making a superfluous load for the ship.




DETAILS OF NEW TYPE OF SHACKLE.

In the second place the shackle, together with the abnormal long links, sliding over the anchor gear, cause shocks and stops of the chain; this has to be taken under consideration not only when making, but also when working the ground tackle. These shocks result, on the other hand, from the length and breadth of the shackle not being made to fit in the grooves of the capstan, so that the shackle sliding over the anchor gear jumps over these grooves; and, on the other hand, from the shackle stopping behind projections of the hull or of the anchor gear. In consequence of these reiterated shocks and jumps of the chain, it is always more or less overloaded, breaking frequently; not only very vexatious interruptions of work, but also expensive repairs result.

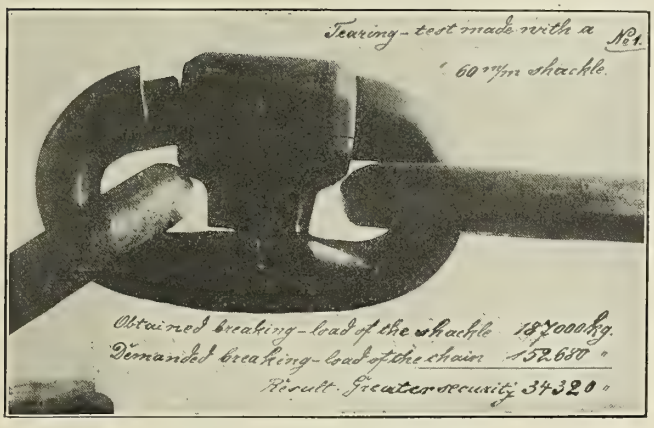
But the greatest disadvantage of the existing shackle is its lack of flexibility, and its limited durability. This lack of flexibility causing a dangerous effect of the lever working between the shackle and the long link is illustrated, showing the necessity of providing for an exceptionally large diameter of the capstan, and also for the rounded pieces of the hawse holes and tubing pipes being exceptionally large, that the joining shackle may slide over the anchor gear without getting caught. The sketch shows that bending strains arise in the jointing, if the radius is too small, and there is no doubt that, at a sudden shock, the force $P$ working on the lever arm $L$ may bend the long link and break the shackle. There is sufficient proof for the fact that such bending strains arise, and it is also proved that link fractures occur more rarely than shackle fractures.

In order to find out what resistance the shackle opposes to the bending strain, shackles made of different materials were tested to their bending limits, as shown. The shackles tested in this way broke in the rounded section after being subjected to relatively light loads, viz., $\frac{1}{5}$ to $\frac{1}{4}$ of the required breaking load. These bending-strain tests have further proved that new shackles, annealed or not, may be bent very much more than those which have been used for some time, and that it is better to make the shackles of soft Siemens-Martin steel than of crucible steel.

The shock resulting from the heaving back of the chain has an essential influence upon the durability of the shackle, for simple tests made by exposing a shackle to the effect of a falling weight of 60-kilogrammeters energy proved that both sides of the shackle being bent left very strong shearing impressions on the pin. That explains, on the one hand, the frequent shearing of pins used but a short time, and, on the other hand, the insignificant bending of the used shackle, because, in consequence of the frequent shock effect and the lever effect of the long link the bending produces changes in the material structure of the rounded part of the shackle.

Considering these defects, which are generally known, endeavors have been made to replace this defective form of shackle by a better one.

A newly patented shackle of compact construction, for the making of which in Germany, Great Britain, and Russia the firm "Duisburger Maschinenbau-Actiengesellschaft, vorm. Bechem & Ketman" has obtained a license, has the form of a stud link. Its dimensions (length and breadth) are similar to those of a middle-sized link, and the thickness of the lock piece is only 1.5 *a* instead of 2.8 *a* of the old shackle head, *a* being the thickness of the chain.


Tearing-test made with a
60 m/m shackle.
Obtained breaking-load of the shackle 187000 kg.
Demanded breaking-load of the chain 152680 "
Result: Greater security 34320 "

SHACKLE PULLED APART IN TEST.

This patented shackle is composed of an open link *a*, the open ends of which are fitted with upper gudgeons, and of the upper and under lock piece. The upper lock piece *b* having the form of hood or cap, covers the upper gudgeons, and goes through the under lock piece *c;* the end of the upper lock piece *b* is fitted with a conical taper catching in an opening *X* of the open link *a*. The under lock piece *c* envelops the under part of the upper gudgeons, serving at the same time as stud and preventing a contraction of the link. The pin *d* serves only to prevent the upper lock piece from falling out. In consequence of the composition and arrangement of the lock piece the fixing pin may be light.

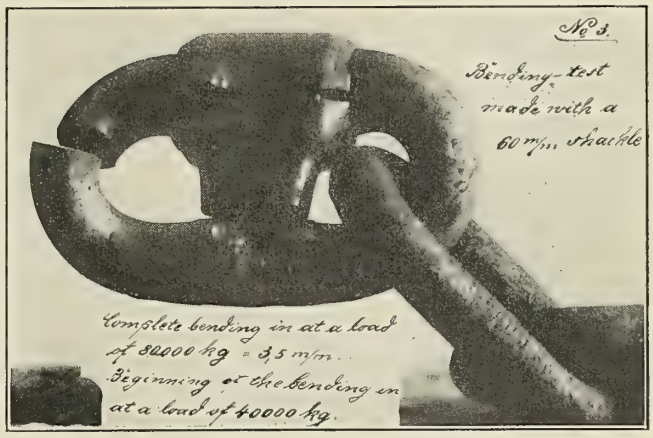
Trials have proved that these new joining shackles can be employed for new chains as well as for old ones for joining ordinary stud links, so that these shackles may be used as ordinary joining links, and also as spare links, avoiding thus the employment of abnormal long links. The suppression of the long links and middle-sized links not only simplifies the making of the shackle, but the possibility of using the shackle as a spare link dispenses also with the necessity of replacing whole lengths of chain in case of chain fractures. Ships need therefore not carry a stock of lengths of chain on board.

Trials made on board a ship of the German Navy for the purpose of determining the handling facility of the shackle have proved that it can slide in any position over the capstan without getting caught. In consequence of the smooth running and the handling facility of the chain, its load will in future be uniform, so that chain fractures need happen rarely.

But the greatest advantage of the new shackle is its great durability; a tearing test made with the chain-test engine in order to find the absolute resistance of the shackle has surpassed the highest expectation. During this test, a joining shackle of 60 mm. proved to be able to stand a load of 187,000 kg., and its broken section proved to have a resistance of 29 kg. per square mm., *i.e.*, 2 kg. per square mm. more than demanded, and 34,320 kg. more than the breaking load of the chain.

In order to see if it would be easy to disengage the shackle even after being heavily loaded the following test was made:

After testing the chain to a trial load of 102,000 kg. and a breaking load of 152,000 kg., the tests were stopped and the shackle closely examined. This examination proved that it was very easy


№ 3.
Bending-test made with a 60 m/m shackle
Complete bending in at a load of 82000 kg = 3,5 m/m.
Beginning of the bending in at a load of 40000 kg.

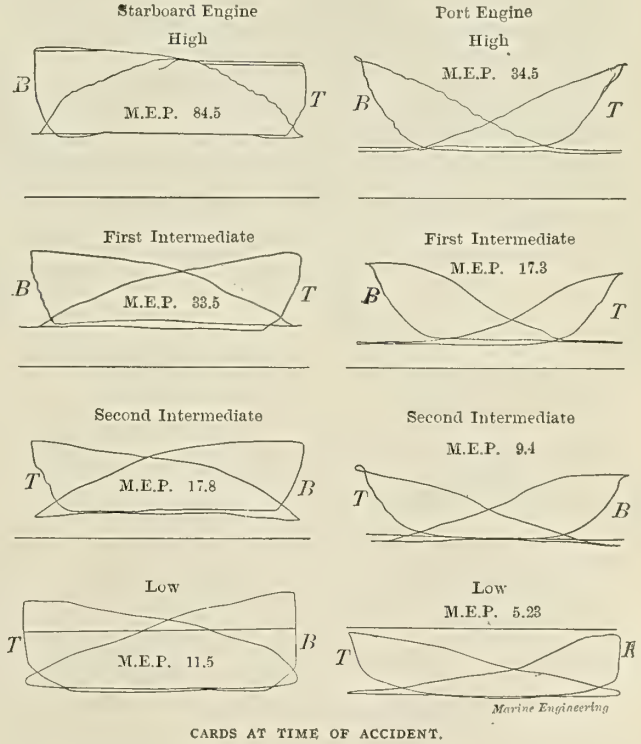
SHACKLE TESTED TO DESTRUCTION.

to disengage the shackle in both cases, and that alterations of the form of the shackle and the lock piece could not be detected. The links of 60 mm. loaded with 159,000 kg. broke, but even after that it was very easy to disengage the shackle and to take off the elongated links. The examination proved further that, even after the breaking of the shackle, the lock piece was quite unhurt.

## Accident to the Königin Luise.

BY W. KIRCHBERGER.

On August 5 the *Königin Luise* left New York for Genoa, and about 8 o'clock on the evening of the 8th she was brought suddenly to a stop by reason of an accident to one of her propellers. Investigation developed the fact that one blade of the port three-bladed propeller had broken off, resulting in increasing the revolutions of that engine (due to partial racing) from 77 per minute to about 90. After the investigation had developed the fact that no damage to the ship had resulted, the voyage was resumed at a reduced speed corresponding with about 63 revolutions per minute, the new speed being about 13 knots. The cards taken from the engines at the time of the accident are rather interesting, and we are reproducing some of them herewith.




CARDS AT TIME OF ACCIDENT.

The *Königin Luise* has a length of 523 feet, a breadth of 60 feet, depth 34 feet, and measures 10,710 tons gross. The twin screws are of a diameter of 19 feet with a pitch of 21 feet 8 inches, and have a projected blade area of 67.3 square feet and a developed area of 80 square feet. They are propelled by quadruple-expansion engines with cylinders measuring 25.2, 38.2, 52.4, and 75.5 inches, with a common stroke of 55.2 inches. These engines develop 7,200 horsepower on a consumption of 118 tons of coal per day. This figures out as 1.52 pounds per indicated horsepower per hour, while the power is sufficient to give the ship a normal speed of 15.3 knots. After the reduction in speed was made the engines developed 4,900 horsepower on a consumption of 98 tons of coal per day, or 1.84 pounds per indicated horsepower per hour. Another element of change in connection with the reduction of speed was a quicker cut-off in the cylinders of the port engine to correspond with the smaller amount of power which could be absorbed by that propeller. This item is shown as follows:

| Cylinder. | Starboard Engine. | | | Port Engine. | | |
|---|---|---|---|---|---|---|
| | Cut-off. | Initial Pressure. | H. P. | Cut off. | Initial Pressure. | H. P. |
| H. P. | .70 | 209 | 856 | .53 | 205 | 298 |
| I. P. (1) | .65 | 92 | 789 | .50 | 81 | 346 |
| I. P. (2) | .65 | 37 | 794 | .50 | 29 | 356 |
| L. P. | .60 | 8.5 | 1 072 | .48 | 2.1 | 417 |

The vacuum into which the starboard engine exhausted its steam measured 25.6 inches, while the port condenser gave a vacuum of 27.8 inches of mercury. Temperature of sea water and of feed water respectively were 21 and 97 degrees Centigrade (70 and 207 degrees Fahrenheit).

The motive power for this boat was built by the Montague Iron Works, of Montague, Mich., and consists in a modern fore-and-aft compound condensing engine with cylinders measuring 14 and 28 inches and a stroke of 20 inches. The high-pressure cylinder is fitted with piston valve and the low-pressure with a double-ported slide valve, both valves being operated by a Stephenson link motion with adjustable cut-off. A direct-connected pump worked from the low-pressure crosshead operates a jet condenser on the aft side of engine. The usual type of horseshoe thrust bearings, steam reversing gear and independent feed and bilge pumps are fitted. Steam is supplied by two Scotch marine boilers furnished with corrugated furnaces designed for wood fuel. The boilers have a diameter of 6 feet and a length of 12 feet, and have been designed for a working pressure of 120 pounds. They were built by Johnson Bros., of Ferrysburg, Mich. The propeller has a diameter of 6 feet and is built of steel; the speed expected is twelve miles per hour.

Accommodation is provided for 600 passengers, the main deck being given over to freight, baggage, engine, boiler, and toilet rooms, while the passenger saloon and a liberal promenade space are to be found upon the saloon deck. The service of the boat will be to carry passengers from the Thumb to the Lake Hotel, thus enabling them to avoid the dusty fifteen-mile stage ride over the Continental Divide.

The boat is named after the president of the Yellowstone Lake Boat Company, which has been engaged in boat transportation on the lake since 1899, when the steamer *Zillah* was placed in service. The *Zillah* has a steel hull which was built and then knocked down and the pieces hauled from Gardiner to the lake, it being found necessary to enlarge the mountain pass at several places and to brace up the roadway in order to move the heavy loads through. A part of the equipment of the shipyard on the shores of the lake includes a marine railway designed for hauling out this steamer.

THE STEAMBOAT WATERS READY FOR LAUNCHING.

THE MEXICAN GUNBOATS AT GENOA.

### A Steam Yacht on Yellowstone Lake.

The yacht *E. C. Waters*, which has been built and put in service by the Yellowstone Lake Boat Company, of Yellowstone Park, Wyoming, is navigating on water 8,000 feet above the level of the sea, and, therefore, without any question the highest navigated water in the United States. Indeed, with the sole exception of Lake Titicaca, in Peru, which has an elevation of 13,000 feet, this is probably the highest navigated water on the globe. The *Waters* was built in a yard on the shores of the lake, being constructed of wood hauled over the mountain road from Gardiner, Montana. The keel and frames are of oak, planking and ceiling of Oregon pine. The length of the boat over all is 135 feet; length on water-line 120 feet; beam 26 feet; depth of hold 9 feet, and draft 8 feet.

### Mexican Gunboats Bravo and Morelos.

In our January number of this year was published a photograph showing the launching of one of these new gunboats, built by Messrs. Odero, at Sestri Ponente, near Genoa, Italy. The ships have now been delivered to the Mexican government and are in service. They have a length of 250 feet, a beam of 34 feet, depth of 16 feet, and displacement of 1,280 tons, and are given very light draft for navigating the shallow rivers of the Mexican coast. They are furnished with twin screws operated by triple-expansion engines of 2,600 horsepower, designed to give a speed of 17 knots. The bunker capacity is sufficient for an endurance of 5,000 nautical miles at a speed of 10 knots.

The cylinder diameters are 15¾, 24⅜, and 37¾ inches, with a common stroke of 19⅝ inches; the revolutions are 265 per

minute. The piston rods have a diameter of 3⅜ inches; crank shafts 6½ inches; crank pins 7⅛ inches, and propeller shafts 7 inches; the connecting rods have a length between centers of 44¼ inches. There are seven thrust collars with an aggregate thrust surface of 2 square feet. The air pump is of the Edwards pattern, measuring 13¾ by 10 inches. A centrifugal pump with a runner diameter of 15¾ inches is actuated by a steam engine 4⅞ by 4 inches. The two surface condensers have each a cooling surface of 1,362 square feet. The number of tubes in each condenser is 1,435, the diameters being respectively 14 millimeters external and 12.4 internal. The length between tube plates is 6

GUNBOATS BRAVO AND MORELOS.

feet 6 inches. The main steam pipe has a diameter of 5 inches and a thickness of 5 millimeters. The propellers are of manganese bronze, three-bladed, with a diameter of 8 feet 2 inches, a pitch of 7 feet 4½ inches, a pitch ratio of 0.903, and a projected area of 16 square feet. The Blechynden water-tube boilers, which are two in number, have a length of 11 feet 8 inches and a width of 7 feet 2 inches; each boiler has one furnace with a grate surface of 59 square feet. The total heating surface is 5,920 square feet, giving a ratio of heating surface to grate surface of 50.1 to 1, and a heating surface of 2.27 square feet for each indicated horsepower. The working pressure is 230 pounds. The wetted surface of the ship is 8,557 square feet.

Two 4-inch rapid-fire guns furnished by the Bethlehem Steel Company are mounted on poop and forecastle respectively with an arc of fire of 150 degrees each side of the center. Four 6-pounder rapid-fire guns are fitted on the broadside and one on the bridge. Electric hoists are used for supplying ammunition to these guns. The crew consists of 25 officers and 90 men, and quarters are also provided for 270 troops. The boat outfit consists of six units, two of which are steam launches. A large refrigerating plant and ample ventilating system are installed.

### Activity in Warship Construction.

September 30, 1905, the warships building in British yards aggregated 42, of a total displacement of 264,310 tons. Of these ships 3 first-class battleships and 5 armored cruisers, aggregating 119,950 tons, are building in royal dock yards; 2 battleships and 4 cruisers, 12 destroyers and 12 submarines, aggregating 93,560 tons, are building for the British government in private yards; and 2 battleships for Japan and 2 large cruisers, aggregating 50,800 tons, are building also in private yards.

On the same date there were under construction in the United States for the United States Navy, 29 warships of an aggregate of 323,650 tons. This total includes 13 battleships, amounting to 196,740 tons; 9 armored cruisers, 114,460 tons; 3 scout cruisers, 11,250 tons; and 4 submarines, 1,200 tons.

The construction of ships of the larger classes for the eight leading naval powers, in order of naval importance, is thus summarized from the September *Proceedings of the United States Naval Institute:*

| | Battleships. | | | Armored Cruisers. | | | Scouts. | | |
|---|---|---|---|---|---|---|---|---|---|
| | No. | Tons. | Mean. | No. | Tons. | Mean. | No. | Tons. | Mean. |
| Great Britain | 7 | 116 400 | 16,629 | 12 | 156,900 | 13,075 | 4 | 10,720 | 2,680 |
| United States | 13 | 196,740 | 15.134 | 9 | 114.460 | 12,718 | 3 | 11,250 | 3,750 |
| France | 6 | 89.190 | 14,865 | 6 | 78,582 | 13.097 | | ..... | ..... |
| Germany | 6 | 84,800 | 14.133 | 4 | 42.000 | 10 500 | 9 | 29,200 | 3,244 |
| Italy | 4 | 50.500 | 12,625 | 2 | 19 290 | 9 645 | .. | ..... | ..... |
| Japan | 3 | 48,750 | 16,250 | 2 | 24 000 | 12 000 | .. | ..... | ..... |
| Russia | 5 | 71,776 | 14,355 | *1 | 6 000 | 6 000 | †3 | 20,250 | 6,750 |
| Austria | 3 | 31,800 | 10.600 | 1 | 7,400 | 7,400 | .. | ..... | ..... |
| Total | 47 | 689,956 | 14 637 | 36 | 442,632 | 12,295 | 16 | 51,170 | 3.198 |

* Coast defense. † Protected cruisers.

### Progress of Naval Vessels.

The Bureau of Construction and Repair, Navy Department, report under date of November 10, 1905, the following percentage of completion of vessels building for the United States Navy:

| | | | Oct. 1. | Nov. 1. |
|---|---|---|---|---|
| **BATTLESHIPS.** | | | | |
| Virginia | 19 knots. | Newport News Co. | 94.24 | 95.31 |
| Nebraska | 19 " | Moran Brothers Co. | 81. | 82. |
| Georgia | 19 " | Bath Iron Works | 87.44 | 89. |
| New Jersey | 19 " | Fore River Shipbuilding Co. | 90.1 | 92.1 |
| Rhode Island | 19 " | Fore River Shipbuilding Co. | 93.7 | 95. |
| Connecticut | 18 " | Navy Yard, New York, N. Y. | 89.39 | 91.3 |
| Louisiana | 18 " | Newport News Co. | 87.73 | 89.25 |
| Vermont | 18 " | Fore River Shipbuilding Co. | 63.8 | 65.8 |
| Kansas | 18 " | New York Shipbuilding Co. | 62 7 | 64.9 |
| Minnesota | 18 " | Newport News Co. | 73.86 | 75.41 |
| Mississippi | 17 " | Wm. Cramp & Sons. | 40.87 | 43.31 |
| Idaho | 17 " | Wm. Cramp & Sons. | 36.22 | 39.19 |
| New Hampshire | 18 " | New York Shipbuilding Co. | 20 4 | 25. |
| **ARMORED CRUISERS.** | | | | |
| California | 22 knots. | Union Iron Works. | 82.9 | 84.3 |
| South Dakota | 22 " | Union Iron Works. | 81.9 | 83.2 |
| Tennessee | 22 " | Wm. Cramp & Sons. | 86.08 | 87.8 |
| Washington | 22 " | New York Shipbuilding Co. | 85.8 | 87.9 |
| North Carolina | 22 " | Newport News Co. | 19.2 | 23.13 |
| Montana | 22 " | Newport News Co. | 16.81 | 19.21 |
| **SEMI-ARMORED CRUISERS.** | | | | |
| St. Louis | 22 knots. | Neafie & Levy Co. | 79.69 | 81.28 |
| Milwaukee | 22 " | Union Iron Works. | 82. | 84.01 |
| **SCOUT CRUISERS.** | | | | |
| Chester | 24 knots. | Bath Iron Works. | 6.11 | 9. |
| Birmingham | 24 " | Fore River Shipbuilding Co. | 9.3 | 12.6 |
| Salem | 24 " | Fore River Shipbuilding Co. | 8.2 | 12 3 |
| **SUBMARINE TORPEDO BOATS.** | | | | |
| Submarine No. 9 | ..... | Fore River Shipbuilding Co. | 25.4 | 30.6 |
| " " 10 | ..... | Fore River Shipbuilding Co. | 21.1 | 23. |
| " " 11 | ..... | Fore River Shipbuilding Co. | 23.6 | 29.3 |
| " " 12 | ..... | Fore River Shipbuilding Co. | 23.1 | 25. |

**The Fifty-second meeting of the American Society of Mechanical Engineers** will be held during the first week in December, beginning with Tuesday evening, December 5, and ending on Friday morning. Papers will be presented on Thursday and Friday mornings, and the usual reception will occur at Sherry's Thursday evening. The remaining sessions will be devoted to lectures and business. The sessions will be held at 44 West 27th street, except that of Wednesday morning, which will occur in the main saloon of the steamship *Amerika,* at Hoboken.

### Extract from a Letter to Marine Engineering from New Orleans, Dated October 27, 1905:

Yesterday President Roosevelt made a trip down the river front on the *Comus.* I hope his attention was called to the fact that among the many ships loading here, the British, Austrian, Spanish, Italian and German flags were in evidence. The *Missouri* was the only American ship loaded for a foreign port.

# Marine Engineering

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Notice to Advertisers.

*Changes to be made in copy, or in orders for advertisements, must be in our hands, in New York, not later than the 10th of the month, and in London, for the English edition, not later than the 20th, to insure the carrying out of such instructions in the issue of the month following.*

*The edition of the December issue of Marine Engineering comprises* 8,250 *copies. We have no free list, accept no return copies and issue only enough to supply the regular demand, so that the* 8,250 *copies represent legitimate circulation.*

| | |
|---|---|
| United States merchant marine, 1805... | 1,140,367 tons |
| United States merchant marine, 1861... | 5,539,813 tons |
| United States merchant marine, 1905*.. | 873,028 tons |
| Great Britain merchant marine, 1861... | 5,195,217 tons |
| Great Britain merchant marine, 1905... | 17,009,720 tons |

Comment is superfluous.

*In foreign service.

### Our English Edition.

Beginning with our January number, Marine Engineering will be published simultaneously in London and New York. This extension of our business is a result of the demand from not only all parts of the British Empire, but the continent of Europe as well, which makes it necessary for us to make our London office a regular publication office. We wish to announce that all advertisements appearing in the American edition will be published also in the English edition, and *vice versa.*

### Convention Notes.

The annual convention of the Society of Naval Architects and Marine Engineers, which took place during the third week in November, contained an unusually interesting and well-balanced series of papers which might be summarized somewhat as follows:

Three papers on propellers and propulsion; six papers on warships, covering design and construction as well as trial trips; two papers on steam turbines; four papers on yachts and launches; one each on the strength of ships, troubles with boilers, and ventilating-fan experiments.

The two papers upon marine steam turbines have been rendered very timely by the great impetus which has been given to the development of that method of propulsion during the past year, not only in this country but, and in greater measure, abroad. In the United States there has been constructed and put into service up to date only one vessel propelled by the steam turbine, and this was simply experimental. There are now under construction, however, a considerable number of ships for both mercantile service and the United States Navy, which are to be propelled by this new motor. These ships cover a wide range of application, from high-speed naval scouts and fast coastwise passenger steamers to large passenger and freight steamers of medium speed and great carrying capacity; and it is confidently expected that the results obtained from the use of the turbines in these ships will lead to their immensely greater application in subsequent constructions. As we are going to press, news is received that the Cunard liner *Carmania,* propelled by turbines, made a speed over the measured mile of more than 20 knots, and a continuous speed for six hours of upward of 19.5 knots. This is safely in excess of the speed developed by her sister ship *Caronia,* propelled by quadruple-expansion vertical marine engines of the usual reciprocating kind. The speed of the *Caronia* on the measured mile was 19.62 knots, and a little more than 19 knots was maintained on the long-distance run.

The address of the president called attention in no uncertain terms to the condition of our deep-sea merchant marine, and pointed out the great differences between the conditions of the shipbuilders on the great lakes and those on the Atlantic and Pacific coasts. He quoted from the report of the Merchant Marine Commission, and made an eloquent plea for the restoration of the American merchant marine to its logical and legitimate position upon the high seas.

This idea was entered into more fully by the Honorable Jacob H. Gallinger, United States Senator from New Hampshire, in an address delivered at the annual banquet of the society, at the close of the convention. Senator Gallinger pointed out the fact that the method of obtaining relief from the situation which now oppresses both shipbuilder and shipowner must of necessity take the course of some assistance from the national government, supplemented, it may be, by additional assistance from the states and municipalities most directly interested in the problem, and to be most greatly benefited by its satisfactory solution. He also pointed out the fact that such assistance as the national government was called upon to give in the bill presented by the Merchant Marine Commission was not by any means the financial burden which has been

generally supposed to be the case. It is specifically provided that in no year shall the total amount exceed nine million dollars, and it is estimated that for the first year it would be only slightly in excess of one million, and for the second year about two millions; these amounts being in each case the excess payment over and above increased tonnage dues collected from ships of all nations. It may be here remarked that the nine million dollars above mentioned is the gross outlay, and that its net effect upon the finances of the nation would be much decreased by the application of these tonnage dues.

He called attention to the fact that one of our great metropolitan newspapers had come out the previous Saturday (November 11, 1905), with an editorial entitled "Plain Subsidy," and we cannot do better than quote *in toto* this editorial from the *Sun:*

> In the course of human events the word subsidy has lost the unpleasant sound it used to have to American ears.
>
> A month ago to-morrow the American Bankers' Association, a conclave of gentlemen not directly interested in the profits of maritime traffic, but tremendously concerned for the prosperity of this nation as a whole, declared boldly and squarely and honorably and finely its approval of the ship-subsidy measure that has appealed in vain to Congress for more years than it amuses us to count.
>
> The bankers did not blink or balk at the word subsidy. They sought no periphrase. They went straight at the gist of the question and couched their resolution in language of a directness and emphasis that must have gladdened the ever patriotic and still youthful heart of the Hon. William Pitt Frye of Maine.
>
> We believe the country is coming to the conclusion reached years ago by that devoted friend of the American merchant marine, and by other far-sighted advocates of the only efficient or available measure for the restoration of the flag to its old place in the sea-carrying business of the world's commerce. The bankers have got there now. Everybody will get there who pursues faithfully and without prejudice the same course of disinterested reasoning.
>
> What an opportunity for the Fifty-ninth Congress to win immortal glory by the legislation that shall at last re-create the American merchant marine and put it at the front for the next half century!
>
> What an opportunity for the leader of American progress and the chief representative of an expansive national destiny to clinch the matter by a single word uttered in his next message with his accustomed perception of the psychological moment!
>
> Subsidy—just plain subsidy.

That the trade between the United States and Europe, both in passengers and in freight, offers exceptional inducements to those who can operate ships at the low rate of expense possible to our English, French and German maritime competitors is amply evidenced in the fact that each nation is at present constructing ships of the largest size designed exclusively for this service. Some of these ships are of very high speed, while others are of the very popular and comfortable "intermediate" type.

Not to mention numbers of ships of 12,000 tons or under which have been put into service by our competitors during the past year or two, we can list ten ships, each of 15,000 tons and upward, three of which have been placed in the North Atlantic service between Europe and the United States during the present year, while all of the remainder but two will be placed in that service during 1906, and the last two in 1907. Four of these ships are German, of which two belong to the Hamburg-American line and two to the North German Lloyd. The former are respectively, the *Amerika*, 22,724 tons, and the *Kaiserin Auguste Victoria,* 25,000 tons, both being intermediates of the most luxurious type. The two North German Lloyd steamers are the *Washington,* 17,000 tons, an intermediate, and the *Prinzess Imperial Cecilie,* 19,500 tons, which is virtually a sister ship to the *Kaiser Wilhelm II,* and of very high speed. Five English ships are included in the list, of which four belong to the Cunard line, and one, the *Adriatic,* 24,000 tons, is a sister to the big intermediate *Baltic* of the White Star line. The four Cunard ships are the *Caronia* and *Carmania* of 19,593 tons each, and the two mammoth flyers of 25,000 tons and 25 knots speed. The single French contribution to this magnificent array of ships is *La Provence,* 15,000 tons, of the Compagnie Générale Transatlantique, which is to reach the United States some time during the coming year. The ten ships above listed aggregate 202,410 gross tons, or an average of 20,241 tons each. This average is larger than any ship in existence in the year 1900, and shows not only the great increase which has taken place in the size of ships since that period, but also the fact that these large ships are very popular, relatively economical to operate, and extremely valuable not only to their owners, from the great returns made, but to the governments under which they are operated because of the possibility of their being used, if necessary, in connection with war service, as transports if they are of the intermediate type, and as scouts when they possess the high speed of four of the examples above quoted.

The mere fact that not a single American ship is being built or is contemplated for this service—that not a single ship of any importance has been built in American yards for North Atlantic service since the *Finland* and *Kroonland* of 12,760 tons were turned out at Philadelphia in 1902—serves as a sad commentary when viewed in connection with the tremendous and wonderfully valuable contribution to that trade represented by the ten ships above mentioned. It is humiliating to Americans to have to recognize this fact.

## ABSTRACTS FROM RULES AND REGULATIONS OF THE GREAT LAKES REGISTER.

EDITION OF 1904.

ARRANGED BY HARRISON S. TAFT.

*(Continued.)*

### 18. Shaft Tunnels.

1. They must be built of steel or iron. When worked in connection with an inner bottom in the cargo space, they are to be of at least 15 pounds plating. Said tunnel is to be caulked watertight.

2. The stiffeners are to be of the same scantling as the reverse bars and be spaced not more than 2 frame spaces apart.

3. Under cargo hatches the plates are to be worked double.

4. There shall be a watertight door in the bulkhead at the forward end of said tunnel; same to work from the deck above the load water-line.

5. There shall be a stuffing box to the shaft where it passes through the bulkhead at the forward end of the tunnel.

6. There shall be a well at the aftermost frame space of said tunnel.

### 19. Shell Plating.

1. All shell plates except those at the extreme ends of ships should be at least 6 frame spaces in length. For all practical purposes the width of the side and bottom plates can be 1-4 of their length. If desired the width of the inside strakes can be from 10 to 15 per cent. more than the outside strakes. Butts of adjoining strakes should have at least a two-frame space shift from each other.

2. The midship weight is to extend for 1-2 length amidships. Forward and aft of said 1-2 length the weight of the plating can gradually be reduced as noted in Table 5. When intended for winter work the weight of midship plating should be carried all the way to the stem. Adjoining plates of the same strake should not differ in weight by more than 10 per cent. When the machinery is located aft the full midship weight must be maintained to after part of the machinery space.

3. Single-bottom vessels are to have their garboards, bottom, and bilge strakes 12 per cent. heavier than when a double bottom is worked.

4. No reduction from midship weight will be allowed on the boss plates of single-screw vessels or on the strake below them.

5. Sheer Strake.

(*a*) When the machinery is located aft the midship weight of said strake is to extend for 2-3 the vessel's length forward from the after end of the machinery space.

(*b*) When a sheer strake extends above the gunwale bar to such a height as to require two rows of rivets, a butt strap should be worked on the inside of said strake, extending from the stringer plate to the top of said sheer strake when double straps are used; the gunwale bar being joggled around said strap. When a single strap is used it is to be worked on the outside of said strake.

(*c*) When a sheer strake is cut for a port door or has large dead lights located in it, it must be strengthened at said points.

6. Steel Tow Barges.

The following reductions from the tabulated midship weights will be allowed in steel tow barges: side plating, 5 per cent.; bilge strakes and garboards, 8 per cent.; sheer strakes, 10 per cent.

7. Bulwarks.

Weight of bulwark plating should be in proportion to its depth, but it should not be of less than 10 pounds. A stiffening angle should be riveted to its upper edge, said angle being bracketed to the bulkheads at the end of a poop or forecastle deck. The bulwarks should be well braced by stanchions, having a sectional area equal to that of the reverse bars. Said stanchions to be spaced not more than 4 feet apart.

8. The awning-deck sheer strake should be 35 per cent. heavier than the side plating next below it.

9. In raised quarter- and poop-deck vessels no reduction will be allowed in the upper-deck sheer strake in the after end of said vessels. (See section No. 33.)

TABLE 5.—REDUCTIONS IN SHELL PLATING AT ENDS.

| Weight of Plating for ½ length Amidships. Lbs. | 13 | 14 | 15 to 23 | 24 to 25 | 26 to 28 | 29 to 35 | 36 to 40 |
|---|---|---|---|---|---|---|---|
| Reductions for first twelfth at ends. Lbs. ..... | 2 | 2 | 3 | 4 | 5 | 6 | 7 |
| " " second " " " " ..... | 1 | 2 | 2 | 2 | 3 | 4 | 5 |
| " " third " " " " ..... | 1 | 1 | 1 | 1 | 2 | 2 | 2 |

Reductions to be figured from midship weights.

### 20. Butt Straps.

1. Double butt straps must be fitted to floors; center-line keelsons; sheer strakes; bilge strakes; stringers; tie plates; bottom longitudinals; and all other parts where possible. (See Table 8.)

2. When, by Table 8, double straps are fitted to the sheer strake and stringer plates amidships, single straps may be fitted to said plates at the ends.

3. When the edges of the butt straps are beveled their width must be increased by the amount of bevelling.

4. The transverse seam straps of the tank-top plating should be 15 per cent. larger in sectional area than the straps of the longitudinal seams of said plating.

5. When double straps are fitted to the sheer strake the outside one is to extend to the top of said strake in one length, the inside one stopping at the under side of the deck stringer.

6. Butt straps should be fitted to the butts of all doubling plates.

7. All bosom pieces to the center line, side keelson, or bottom longitudinal angles, or bulb angle bars, must be at least 2 feet long.

8. For further details of butt straps see Tables 7 and 8.

TABLE 6.—WEIGHT OF BUTT STRAPS. LBS.

| Weight of plate in lbs. | 10 | 12½ | 15 | 17½ | 20 | 22½ | 25 | 27½ | 30 | 32½ | 35 | 37½ | 40 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Single straps. Double and treble riveted.... | 12 | 15 | 18 | 21 | 24 | 27 | 30 | 33 | 36 | 39 | 42 | 45 | 48 |
| Double straps. Double, treble or quadruple riveted { Inside straps | .. | .. | 10 | 12 | 13½ | 15 | 16½ | 18 | 20 | 22 | 24 | 25½ | 26½ |
| Double straps. Double, treble or quadruple riveted { Outside straps | .. | .. | 11 | 13 | 14½ | 16½ | 18 | 19½ | 22 | 24 | 26 | 27½ | 28½ |

The weight of outside straps of double butt straps is for those with countersunk rivet holes. When the outside straps are not countersunk they may be of the same weight as the inside straps.

## 21. Riveting.

1. The system of riveting adopted for the longitudinal seams amidships must be continued all fore-and-aft to the ends of the ship; said seams of the shell plating being chain riveted.

2. When the longitudinal seams of the shell plating amidships are treble riveted, double riveting may be used at the ends.

When said midship seams are quadruple riveted, treble riveting may be used at the ends.

3. When, by Tables 8 and 9, treble riveting is called for amidships, double riveting may be used at the ends. When said tables call for quadruple riveting amidships, treble riveting may be used at the ends.

4. When, by Table 8, the butt straps of the shell plating are to be quadruple riveted and the frame spacing is 24 inches, the diameter of the rivets need not exceed 1 inch.

5. Doubling plates should be well riveted together on their edges and have extra frame rivets.

6. Countersinks of all shell plating, stringers, and deck plating should extend through the plates 3-4 of their thickness.

7. Rudder rivets are to be of the same size as those used in the bottom plating amidships.

8. Beam knees should be double riveted to both the beam and the frame.

9. Bosom pieces at the butts of the reverse bars are to have 3 rivets in each flange on each side of said butts spaced as per frame rivets.

10. Bosom pieces at the butts of continuous keelson bars are to have three rivets spaced 5 diameters apart on each side of said butts.

11. THE FOLLOWING TO BE SINGLE RIVETED:

(*a*) Longitudinal seams of the deck plating.

(*b*) Butts of all deck plating at ends of ship.

(*c*) Longitudinal seams of the tank-top plating, except those of the center-line strake.

(*d*) All butts of the tank-top plating outside of the engine room, except those of the center line and margin strakes.

(*e*) Longitudinal seams of the bottom and bilge plating when under 15 pounds.

(*f*) Longitudinal seams of the side plating when of 17 1-2 pounds or less.

12. THE FOLLOWING TO BE DOUBLE RIVETED:

(*a*) All butts of the shell plating, sheer strakes, stringers, and tie plates, to be at least double riveted throughout. Also the side plating of an awning-, poop-, or quarter-deck vessel.

(*b*) Butts of all plated decks between hatchways.

(*c*) Butts of the lower-deck plating between the stringer plates and hatchways throughout.

(*d*) Longitudinal seams of the bottom and bilge plating when of 15 pounds and above.

(*e*) Longitudinal seams of the side plating when over 17 1-2 pounds.

(*f*) Transverse seams of the tank-top plating when of 20 pounds or over.

(*g*) Inner edge of the upper-deck stringer plate when the vessel's length exceeds 400 feet.

(*h*) Longitudinal seams of the sheer strake and flat-plate keel when of 15 pounds or over.

(*i*) Longitudinal seams of the shell plating between the two sheer strakes in spar-deck vessels.

(*j*) Lower longitudinal seam of the awning-deck sheer strake in awning-, poop-, and quarter-deck vessels.

(*k*) Longitudinal seams of the tank-top center-line strake.

(*l*) Tank-top margin plate when flanged to the shell plating.

(*m*) Inner edge of the stringer plate when the vessel's length is 350 feet or above and the hatch width is not over 1-3 of the vessel's beam.

(*n*) Butts of the upper-deck plating between the stringer plate and hatchways at ends, when treble riveted amidships.

(*o*) Knee brackets to the beams.

13. THE FOLLOWING TO BE TREBLE RIVETED.

(*a*) Butt straps of the upper-deck plating between the stringer plates and the hatchways for 1-2 length amidships, when the upper-deck stringer butts are treble riveted throughout as set forth in Table 8.

(*b*) Butts of all floor plates.

(*c*) Butts of all flat-plate keels (at least).

(*d*) Butts of all garboards (at least).

(*e*) Bilge brackets connected to channel floors by double butt straps.

(*f*) Butts of the awning-deck sheer strakes and stringer plates for 3-4 vessel's length amidships, when said deck extends the full length of the vessel.

(*g*) The three aftermost butt straps of each strake of the shell plating between the keel and the deep load water-line in vessels over 168 feet in length, with their machinery fitted aft.

14. The Following to be Quadruple Riveted.

(*a*) Overlapped butts of floor plates when butts of said floors are all in line on the same side of the ship (having four full rows).

(*b*) Bilge brackets which are lapped on to channel floors (having four full rows).

15. For further details of riveting see Tables 7, 8, and 9.

### 22. Double Bottoms.

1. When solid or bracket floors are not fitted, bracket plates are to be fitted to the center vertical keelson on every frame, having double clips to same. Said brackets are to be securely riveted to the frames or floors and be secured to the middle-line strake of the tank-top plating with a single clip. The diagonal edge of said brackets should be flanged.

2. The width of the brackets on the floors should be twice the depth of a channel floor or 1 1-2 times the depth of a plate floor, and should taper to half of said width at the tank top.

3. The side longitudinals on top of floors, or when worked in connection with cellular bottoms, should be spaced not over 4 feet 6 inches apart. They should be worked continuously through all watertight floor with watertight staple work at same. They may be worked intercostally throughout the engine-room space.

4. (*a*) In steamers of 250 feet length intercostal plates or channel chocks should be worked between the floors in way of one of the side longitudinals. When said length exceeds 300 feet said channel chocks or intercostal plates should be worked in way of all the longitudinals.

(*b*) Barges and sailing vessels are to have said intercostal plates or channel chocks as follows:

| Length of Ship. | Arrangement of Chocks. |
|---|---|
| 300 feet, under 375 feet. | In way of one side longitudinal. |
| Over 375 " " 425 " | " " " two side " |
| 425 and above. | " " " all " " |

5. There shall be a single angle bar at the top and bottom edges of said longitudinals worked continuously. There shall be a vertical stiffener at each floor.

6. Under the boiler room solid manhole plate floors are to be fitted to alternate frames, but to every frame under the engine room.

7. The center-line keelson is to be caulked watertight. It should be increased in weight by 10 per cent. within the machinery space.

8. The bilge brackets on the underside of the margin plate are to be of two sizes, the larger one being fitted at the web frames.

9. A drainage well should be fitted at the after end of the engine compartment.

10. When a cellular bottom is adopted, solid manhole plate floors or bracket plate floors must be fitted intercostally between the continuous side girders (see 3, above), on alternate frames. The size of said manholes to be such as to leave a clear plate surface all around the hole equal to 2 1-2 times the depth of the standing flange of the angle frame.

11. In cellular bottoms the intercostal floor plates or brackets may be 12 per cent. lighter than otherwise.

### 23. Tank Top.

1. When the machinery is fitted aft, as typical with bulk freight vessels of the Great Lakes, the tank top should extend from the forward collision bulkhead to the bulkhead at the forward end of the machinery space. It may also be worked throughout the machinery space.

2. The plating, except the center line and margin strakes, may be worked longitudinally or transversely, as desired; all with flush seams. The center line and margin strakes must be worked longitudinally.

3. When no wood ceiling is fitted on top of the tank-top plating said plating (except the margin and middle line plates) should be of the same thickness as the middle-line strake; all with flush seams.

4. The tank-top bed plate in the engine room is to be made extra heavy as specified, and be well supported by extra solid plate floors and intercostal keelsons.

5. Manholes should be so arranged in the tank top as to provide of ready access to all parts of the inner bottom.

6. The margin plates may be connected to the shell plating by a suitable flange on said plates when the frames are cut at the tank top. Or a continuous angle bar may be worked in lieu of said flange.

7. The tank-top frame brackets must have a flanged diagonal edge or have a small angle-bar clip on same for securing the bilge ceiling to said brackets. The bilge ceiling must be grain tight.

8. The tank-top frame brackets are to be of the same weight as the plates of the side longitudinals, and have double clips of reverse-bar size connecting them to the margin plates.

9. The watertightness of the tank top is to be tested by a head of water equal to that of the deep load water-line.

10. All water-ballast tanks and inner-bottom compartments are to have at least one sounding pipe 1 1-2 inches in diameter, and two air pipes 2 1-2 inches in diameter.

### 24. Boiler Enclosures.

They must be of steel. When built above or below the weather deck the plating of same must be of at least 8 pounds for steel, but 10 pounds for iron, properly stiffened. Doors are to be of not less than 10 pounds plating. The tops of all door sills are to be of at least 12 inches above the deck. When said enclosures are fitted to a wood coaming the plating is to be connected to said coaming by a 4- by 8-inch angle bar with its shortest leg vertical.

### 25. Hatchways and Deck Openings.

1. The width athwartships of the hatches, as used on bulk freight vessels of the Great Lakes, should not exceed 2-3 the vessel's beam, or be over 8 feet fore-and-aft, being spaced 24 feet center to center.

2. The hatch coamings of the upper deck should stand not less than 8 inches above the deck, being of bulb angle.

3. Suitable strong backs should be provided to support the hatch covers.

4. When the fore-and-aft length of a hatch or deck opening exceeds 12 feet, shifting beams, spaced not over 8 feet apart, must be provided. When said length is 18 feet the end beams of said hatch must be made 1-16-inch thicker than otherwise.

5. The fore-and-aft coamings at side of hatches that are 6 but under 9 feet in length must have suitable stanchions, and web frames to support same.

6. Companionways on exposed decks are to have coaming plates of the same height as the depth of the deck beams to which they are attached.

7. Coamings of scuttles to cargo holes located on the upper deck are to be of the same depth as those of the cargo hatches.

8. Hatch Covers. They may be of pine 2 inches thick with oak carlings; or built in sections of 3- by 3 1-2-inch pine edge bolted and grooved at each end to fit over the bulb coamings. They must be provided with tarpaulins and suitable batterns for holding them down.

### 26. Wood Decks, Ceilings, Etc.

1. When a wooden deck is fitted, longitudinal and diagonal tie plates must be fitted to the deck beams with the deck planking scored over same. The deck planking is to be of white, yellow, or Southern pitch pine.

2. On exposed decks the width of the deck planks should not exceed 6 inches, with single fastenings. When the width of the deck planking exceeds 6 inches double fastenings are to be used.

3. The fastenings shall consist of galvanized screw bolts and nuts, the head of the bolts being let into the planking, bedded in wax and white lead, with a deck plug over the bolt head.

4. When laid on a steel deck the thickness of the deck planking may be reduced by 1-2 inch from the tabular requirements, but to be not less than 2 1-2 inches thick.

5. The steel deck is to be well coated with oil or other approved substance before the deck planking is laid thereupon.

6. Wooden decks must not be worked in way of the engine, boiler, or coal-bunker spaces.

7. All steel and wood decks are to be properly caulked and made watertight.

8. Single-bottom vessels should be close ceiled to the upper turn of the bilge and spar ceiled on the sides. Said ceiling on the sides is to be secured to the reverse frames by a bolt and nut. A ceiling should be laid on the tank top under hatches. In bulk freight vessels no side ceiling will be required.

9. A stiff coat of Portland cement wash is recommended for peak tanks, and the interior of double bottoms. Also for inside of bottom plating, frames, floors, and rivets to the upper turn of the bilge in single-bottom vessels.

10. All other parts of the steel work are to have three coats of good oil paint.

### 27. Valves; Drains; Scuppers, and Freeing Ports.

1. A substantial strainer should be fitted on the outside of the shell at all sea connections.

2. A suitable stuffing box should be fitted to all pipes where they pass through a watertight floor or bulkhead.

3. The suction boxes to all ballast tanks should be located at the aftermost part of said tanks, close to the center line.

4. No valves or cocks shall be fitted to the forward collision bulkhead, the peak being fitted with a syphon or pump.

5. Suitable means should be provided for draining the tank top and boiler deck.

6. The suction pipe to the fore-and-aft peaks and to the tunnel well should be not less than 2 inches inside diameter when gross tonnage is under 500, but 2 1-2 inches when said tonnage is 500 or above.

7. Scuppers are to be fitted to all decks, those to the lower decks leading to the bilge or water bottoms. Scuppers to the upper deck are to lead to openings in the top side plating below the main sheer strake.

8. When the bulwarks exceed 30 inches in height, and in all well-deck type of vessels, the total area of the freeing ports is to equal 1 square foot for each 30 superficial square foot of bulwarks for 2-3 length amidships. In all other vessels the total area is to equal 1 square foot for each 45 superficial square foot of bulwarks for 2-3 length amidships.

9. In tow barges the manifold box is to be placed in a separate watertight compartment extending to the main deck.

### 28. Rudders.

1. Pintles should not be spaced over 5 feet apart. They should be fitted independently in the frame.

2. The plating is to be from 10 to 17 1-2 pounds, with wood filling between the plates. In high-speed steamers the plates should be double riveted to the frame.

3. There shall be a stuffing box on top of the transom floor.

4. The rudder must be arranged so that it can be unshipped while the vessel is afloat.

5. Balanced Rudders.

(*a*) The plating is to be not under 10 or over 20 pounds, with solid wood filling between the plates. In steamers with a speed of over 14 miles an hour the plates are to be double riveted to the frame.

(*b*) The foot pintle is to be in diameter 1-2 the tabulated diameter of the rudder's head.

(*c*) With the present style of rudders used on the Great Lakes the best results are obtained when 20 per cent. of the width of the blade is forward of the rudder post.

### 29. Spar-Deck Vessels.

1. When the deck next below the upper deck is worked continuously and is fully laid, the side plating between the upper-deck sheer strake and the second deck can be reduced by 15 per cent., provided the main sheer strake or shell strake in way of the second deck is increased by an amount equal to the above reduction.

2. There shall be a doubling plate to the sheer strake over the cargo port doors extending two frames fore-and-aft of the frames at the ends of said port.

### 30. Awning-Deck Vessels.

1. This class of vessels consist of those having a light superstructure built upon the upper deck for light goods or passenger purposes. In no case will said structure be permitted in single-deck vessels.

2. The deck next below the awning deck must be continuous and fully laid. The hatch coamings of this deck must be treated as if on an exposed or weather deck.

3. The side plating of the above structure must not be of less than 11 pounds, with no reduction at the ends.

4. The tie plates of the awning deck are to be the same as those for an upper deck.

5. Hatchways in the awning deck must not be over 1-3 the vessel's beam or over 10 feet in a fore-and-aft direction. When for any special reason it is necessary to make said fore-and-aft dimensions more than 10 feet stanchions must be fitted at the hatch corners.

6. When a wooden deck is laid on the awning deck it must be not less than 2 1-2 inches thick.

### 31. Shade Decks.

These decks shall consist of a light superstructure erected above the weather deck with open sides; adding no structural strength to the ship.

### 32. Raised Forecastle Deck.

1. The beams of said decks are to be located on alternate frames efficiently supported by stanchions.

2. When a wooden deck is used the thickness of same is not to be less than 2 1-2 inches.

3. A continuous side stringer is to be worked in the forecastle, midway between decks, ending in a breast hook.

4. The side plates for the raised forecastle should extend two frame spaces aft of said forecastle bulkhead. The plates covering the break should be made 20 per cent. heavier than their adjoining plates.

5. When the length of a raised forecastle exceeds 1-4 of the vessel's length the upper-deck sheer strake is to be made 50 per cent. and the stringer plate 20 per cent. heavier for a distance of some 20 feet at the break.

### 33. Poop and Raised Quarter Decks.

1. The bulkhead at the end of a poop or raised quarter deck should have vertical stiffeners spaced 30 inches apart, properly bracketed at top and bottom.

2. Horizontal bracket plates of the same weight as the bulkhead coaming plates are to be secured to the bulwarks and bulkhead plating midway between decks.

3. When wooden decks are laid a transverse tie plate should be worked on the bulkhead beams so as to provide a proper support for the stiffener bracket plates.

4. The side plates of the poop shall extend two frame spaces forward of the poop bulkhead. The plates covering the break shall be 20 per cent. heavier than their adjoining plates.

5. When the length of a poop deck exceeds 1-4 the vessel's length the upper-deck sheer strake is to be made 50 per cent. and the stringer plate 20 per cent. heavier for a distance of some 20 feet at the break.

6. When the combined length of a forecastle and poop or of a raised forecastle and quarter deck exceeds 40 per cent. of the vessel's length the upper-deck sheer strake is to be 20 per cent. heavier than otherwise between the forward and aft erections.

### 34. Sunken Windlass Deck.

1. The bulkhead at the aft end of a sunken windlass deck should be of the same thickness as the upper part of the collision bulkhead, with angle stiffeners spaced 30 inches apart on the after side. If the height of said bulkhead exceeds 4 feet there shall be a horizontal stiffener on the forward side, equal in section to the main frames.

2. No doors will be allowed in said bulkhead below the weather deck.

3. Said deck is to be made watertight and provided with suitable drains.

4. The chain pipes when possible should extend at least 6 inches above said deck plating.

### 35. General.

1. A suitable ladder is to be fitted to both peaks and to all cargo holds.

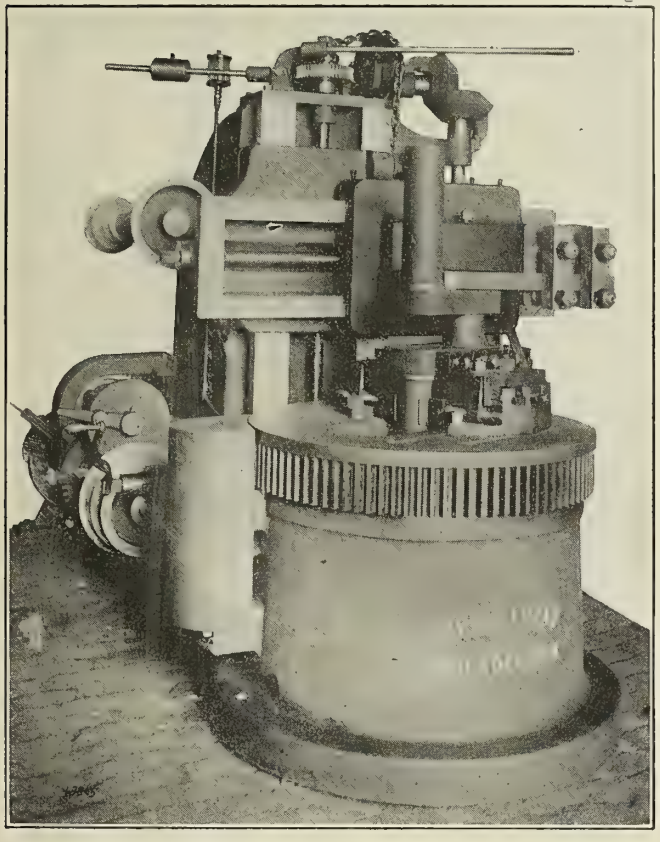
2. Any part of the "chains" that are worn to 1-4 of their original sectional area must be renewed.

3. Note. In view of the modern type of bulk freight "lake vessels," a number of the foregoing rules, etc., are somewhat of an obsolete nature.

## ENGINEERING SPECIALTIES.

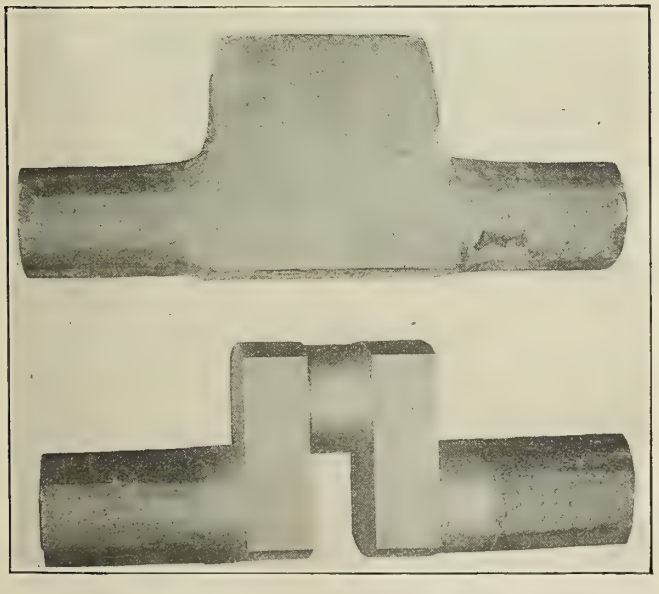
### A Crank-Shaft Forming Machine.

We illustrate herewith a machine designed by the Espen-Lucas Machine Works, of Philadelphia, for the purpose of forming crank shafts from rough ingots, and show also a photograph of one of the crank shafts compared with a rough ingot similar to that from which it was formed. A general method in manufacturing crank shafts heretofore in order to remove the large mass



of metal from the center of the forging has consisted in drilling holes across the web and then sawing through the holes and breaking out the material to be discarded. This resulted in forming a rough square pin. It was then necessary to center the pin and shaft and so balance the forging with jigs that the pin could be turned up in a lathe. The present machine is designed to do away with this clumsy method by taking out the material from the throw, turning off the ends and sides, and finishing the outside of cheeks, and facing off the top and bottom of the crank. These operations for the crank shaft illustrated were accomplished in one hour and thirty minutes, the crank being held vertically in the machine to avoid the strains resulting from the alternate rise and fall of the weighty lump of the forging, which would have been existent had the crank been turned in a horizontal position.

The machine is furnished with a patent universal vise for roughing out crank shafts and a stationary vise for finishing, these vises being adjusted to different sizes of crank shafts. The machine illustrated can handle shafts with throws as high as 20 inches, and for the larger sizes uses a tool 2½ inches wide. Automatic feeds are fitted in all directions. The gears are of hammered crucible steel with bearings lined with bronze. The entire machine, which is extremely powerful, weighs about 20,000 pounds.



A BLANK AND THE MACHINED CRANK.

### Gasoline-Propelled Canal Boats.

The boats shown in the reproduction are the property of the Ohio Boat Company, and are the result of an experiment tried a year ago. At that time one boat, the *Monitor,* was equipped with a 21-horsepower Clifton marine engine, and put in operation on the Miami and Erie Canal between Cincinnati and Lockland, O. This boat did not miss a trip in the entire year, except from such causes as ice, or breakages in the canal banks. The owners of the boat found the gasoline engine so superior to mules that they immediately built six more steel boats and equipped them with this same type of engine. These boats were recently put in operation and have been running steadily ever since.

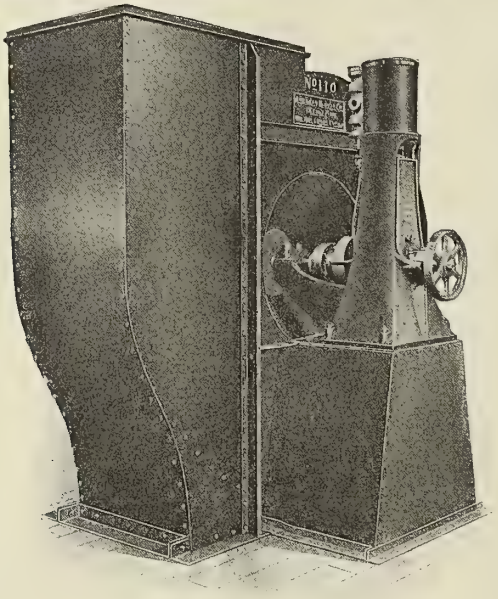
One boat, which has a particularly long run, is equipped with a 28-horsepower engine, while the others have only 21 horsepower, These engines are very economical, the company reporting a great saving in operating expenses over the old mule-drawn boats. In addition to the greater economy, the saving in time is considerable. Where it formerly required twelve hours to make a trip, the gasoline boat makes it in five to six hours. The system of propulsion is known as the "Coen system." The boats have a tunnel built in the center, in which a propeller revolves. To keep the propeller fully covered, an air pump and stand pipe are employed. The engine operates the air pump and maintains a solid body of water about the propeller. The engines were furnished by the Clifton Motor Works, Cincinnati.

### A New Blower Outfit.

Experience has shown that in handling hot gases with a fan, as in a plant producing induced draft for boilers, it is impossible to give the fan shaft a suitable bearing at the inlet side. A bearing here would necessarily be situated in the inlet area and would be constantly surrounded by hot flue gases. Much better results have been obtained by the use of an over-hung wheel, having in

addition to the two engine bearings a bearing on the engine side of the fan, but none on the inlet side. The usual form of construction, that is, providing for a third bearing separate from the engine, has, however, given trouble from the fact that this bearing cannot readily be lined up with the two engine bearings.

A new method of construction which overcomes this trouble has all three journal boxes cast in the engine frame, and all can be bored with the same boring bar. It is thus impossible for them to be out of line. The fan bearing is water-cooled and ring-oiled. The bearing is supported by the engine bed and not by the housing of the fan, as would otherwise be the case. This simplifies the construction by doing away with the additional bracing usually found on fan housings.



The wheel is varied somewhat from the ordinary construction. In place of the usual three spiders is substituted one heavier one built of I-beams cast into the hub. The blades are braced upon each other. The wheel constructed in this manner has been shown to be fully as strong and rigid as the ordinary three-spider form. By the use of a single spider the necessity for more than one hub on the shaft is obviated. In this manner the load of the wheel is concentrated upon a comparatively short length of shaft.

The engine is of the enclosed type, oiled by a recently-devised pump which distributes copious streams of oil over all of the reciprocating and revolving parts, even lubricating the eccentric outside of the frame. Tests in actual practice have proved that it will run several months without re-oiling or adjustment.

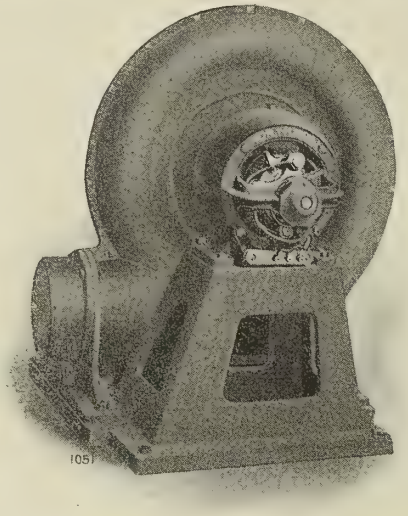
This outfit is manufactured by the American Blower Company, of Detroit, Mich., from whom further information and prices may be obtained.

### Bowes Patent Hose Coupling.

For the purpose of joining two sections of hose for carrying compressed air from the source of supply to any pneumatic tools which may be using it, or for connecting such a hose to a stationary tap, the Cleveland (Ohio) Pneumatic Tool Company has placed upon the market a coupling which is very readily connected, and is so designed as to make a very tight joint under pressure. The sizes are largely interchangeable. The coupling is made in sizes from ¼ inch to 1½ inches.

### Northern Electrical Blower Outfit.

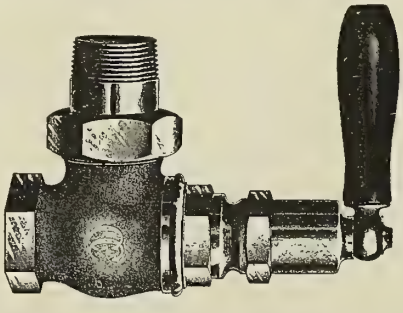
The illustration shows a direct-connected outfit consisting in a motor built by the Northern Electrical Manufacturing Company, of Madison, Wis., and a centrifugal blower or fan used to develop air pressure for the various purposes required on shipboard or in shipyards. The motor is of the spherical design and



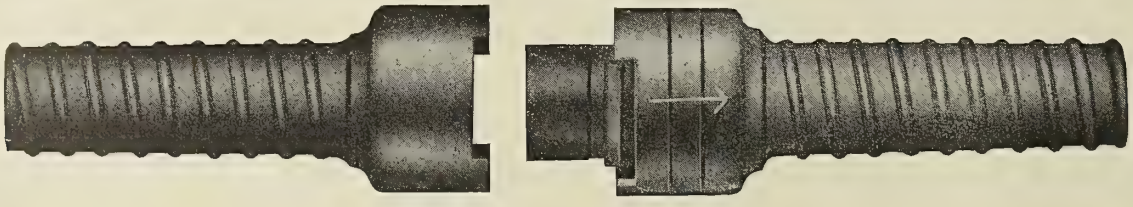
very compact, with great capacity for bearing all sorts of hard usage. It is completely self-contained, and has been found to give very general satisfaction wherever used. It is built in a variety of sizes, with various speeds dependent partly upon the voltage for which it was designed and the work to which it is to be applied. The rated capacities run from 75 to 425 cubic feet of air per minute, at 1½ ounces pressure.

### A New Quick-Opening, Self-Packing Steam Radiator Valve.

The self-packing feature precludes any possibility of these valves leaking at the stuffing boxes. By a special device the packing is automatically kept tight, and will last for years without renewal. The device is very simple, consisting only of a vulcanized washer, located in the top of stuffing box and kept in position by spring compression, which fully compensates for the wear on washer. These valves open and close by turning the lever handle one-half turn. The quick opening and closing feature will be appreciated by users.



The construction is such that when closed the disks bear on the seats very tightly, and the valve is locked in place until released. The bonnets are interchangeable with the bonnets of regular radiator valves. The manufacturers are the Crane Company, Chicago.

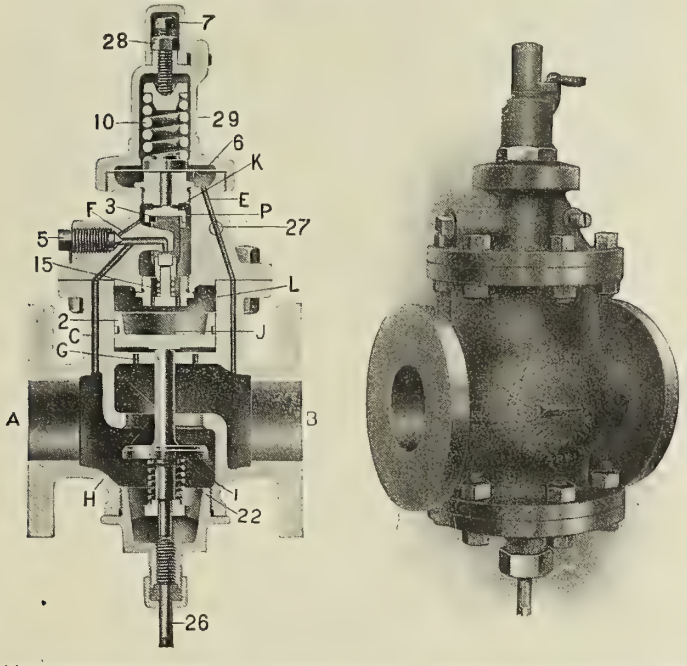


## TESTS OF PRESSURE REGULATORS.

At the plant of the Foster Engineering Company, Newark, N. J., on October 26, were held a number of tests of pressure devices designed for various purposes.

*First Test:* Was of the new type *G* reducing valve, the object of which was to illustrate the delivery of steam at a constant pressure regardless of the variation in the volume of discharge, or increase or decrease of the initial pressure; to show that the valve would operate equally well in a horizontal, vertical, or inverted position or when inclined at any angle; and that the valve would close off dead tight when no steam was being delivered.

In demonstration the valve was first placed on a horizontal pipe in a vertical position. Steam was turned on with the initial pressure at 250 pounds and the valve set to deliver 30 pounds.




The variable volume of discharge was obtained by opening and closing at intervals four one-half inch (½″) outlets connected in manifold to discharge pipe, steam first passing through a small receiving tank. During this test the delivery pressure did not vary one pound. It was then suggested that the receiver be taken off and a one and one-quarter inch (1¼″) quick opening gate valve placed on line direct from outlet of regulator. In this test the quick opening valve was frequently opened and closed without showing a variation of delivery pressure exceeding two pounds. The valve was then inclined at different angles and then inverted, the results obtained in either case being the same as when upright. The initial pressure was then lowered and the delivery, with variable volume of discharge, remained constant until the initial pressure had fallen to 33 pounds, delivery being 30 pounds. The diaphragm was then removed while steam was passing through the valve, delivery pressure being 60 pounds and 30 pounds with the initial at 250 pounds. To remove the diaphragm screw 26 was adjusted to throttle the steam to the desired pressure, by-pass screw 5 opened and port screw 27 closed; tension of spring 10 was then released, when cap 29 was unscrewed and the diaphragm removed. The whole operation required less than five minutes. It was then suggested that all tension be taken off spring to see whether the valve would hold tight while delivering no steam. This was done and the gauge showed no pressure.

*Second Test:* The piston-actuated pump governor was tested to illustrate the maintaining of pressure by speed of pump. The variable volume of discharge test was obtained by manifold being connected from discharge of pump, with the result that the pump speeded up to maximum, discharge being maintained at the predetermined point—100 pounds.

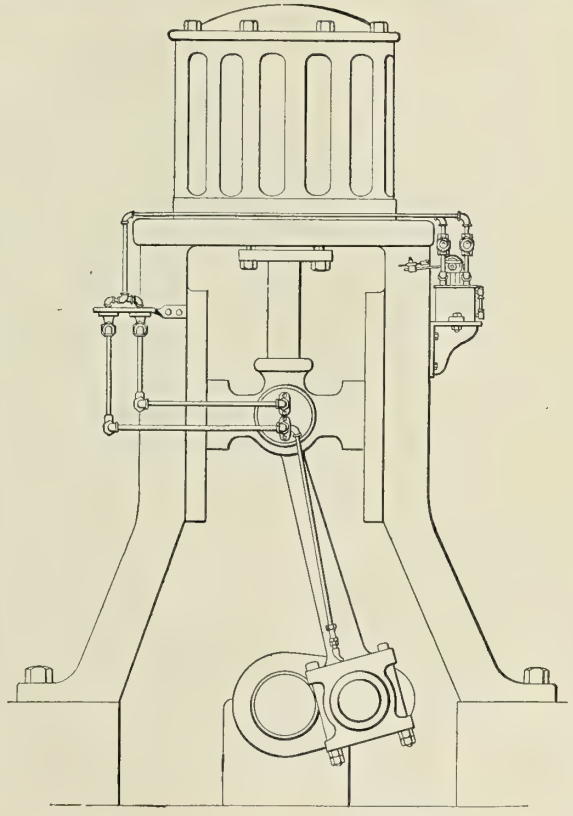
*Third Test:* This test was to illustrate the class *Y* reducing valve to reduce from high initial pressure—1,400 pounds and up—to low delivery, 140 pounds—for the purpose of expelling gases from guns after discharge. An eight-inch iron pipe twenty feet long was used to illustrate the effect of air admitted to inlet of pipe. Oily waste was placed in tube and ignited to produce smoke and flame. A quick opening gate valve was installed on the line to tube from outlet of reducing valve and opened suddenly to expel the gas and flame. The result of the test showed that the reducing valve maintained the delivery pressure as required, and the result was very satisfactory.

*Fourth Test:* This was of the combination valve installed on boiler, the object being to close down in case of a rupture in steam main. A quick opening gate valve was placed in the line and opened to the atmosphere, which gave the same practical result as of a break in the pipe. In this operation the automatic valve on the boiler closed instantly and shut off steam to line. The main valve was then closed by opening a small valve in emergency line, to illustrate emergency closing, with the same satisfactory result.

*Fifth Test:* This was to illustrate the automatic safety stop valve to be used in connection with steam lines whereby the rupture of one line will close valve and shut off steam from that particular line, without shutting down the whole plant. The same quick opening gate valve as in the combination valve test was used, with the result that the automatic safety stop valve instantly closed down.

## Force-Feed Lubricating Pump.

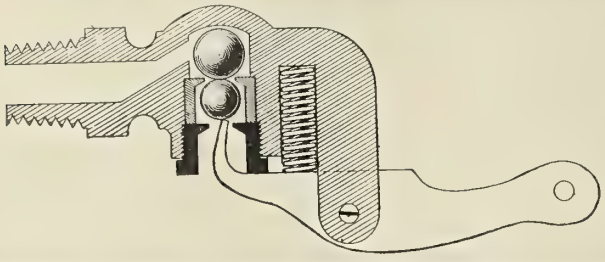
An oiling device for marine use is being manufactured by the Hills-McCanna Company, of 128 East Kinzie street, Chicago, Ill. The oil is distributed from a double pump so arranged as to get the driving motion from the crosshead, and swinging pipes are



arranged for lubricating both the crosshead pin and the crank pin. The conductors are of ¼-inch extra heavy pipe, and run from a bracket on the engine frame to an intermediate pivotal point and thence to the crosshead. At this point one pipe delivers oil to the crosshead pin, while the other, by means of an additional pivot, discharges it through another conductor along the length of connecting rod, and so to the crank pin.

### A New Gauge Cock.

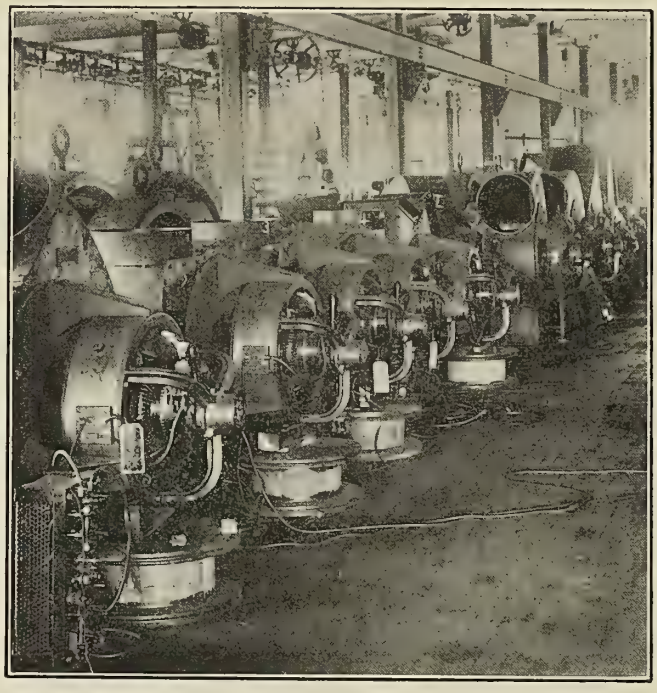
For the purpose of testing the level of water in a boiler, the Ætna gauge cock, which has just been placed upon the market by George W. Neff & Company, 42 Broadway, New York, N. Y., seems very well fitted. As shown in the illustration, the design is very simple, the action being the displacement of a steel ball



from its seat by means of another ball forced against it by a lever. This enables the steam to escape so long as the operator holds the lever in that position, but once released, the pressure of boiler steam forces the ball back upon its seat, and the auxiliary ball upon the auxiliary seat insures an absolutely tight valve. It is made in standard sizes, of hard phosphor bronze, with interchangeable parts.

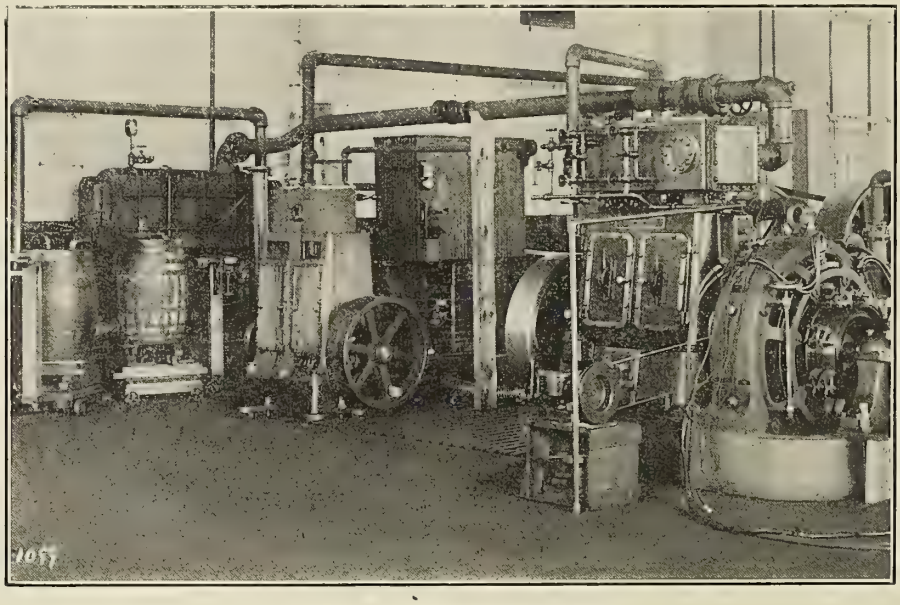
### The Sturtevant Testing Department.

In order to comply with the very rigid requirements of the United States Navy Department with regard to the performance of blowers, fans, and electric generating sets, the B. F. Sturtevant Company, of Hyde Park, Mass., has installed in its new plant a very complete outfit for testing the machinery as manufactured in order to determine its efficiency of operation, and to follow up and remedy any defects which may develop, as well as to obtain information leading to improvements in the various types of mechanism.



TESTING OF MOTOR-BLOWER SETS.

The testing department occupies parts of three floors of the building devoted to the manufacture of fans and heaters; the two upper sections being used for the testing of the lighter equipment connected with the operation of blowers and fans, while the large testing space on the first floor is used for electric-lighting sets. The testing plate measures about 30 feet by 60 feet, and is completely equipped with steam and electrical connections in such a way that engines may be run either condensing or non-condensing, and all sorts of tests made for determining power and efficiency, as well as for adjusting valves and for obtaining any sort of information which may be desired. Condensers and heaters are used in connection with the work, while the electrical part of the equipment is designed to absorb the power developed by the generators and make possible the determination of its amount. We present herewith two photographs showing respectively the fan-testing plant and the plant for testing direct-connected lighting sets.

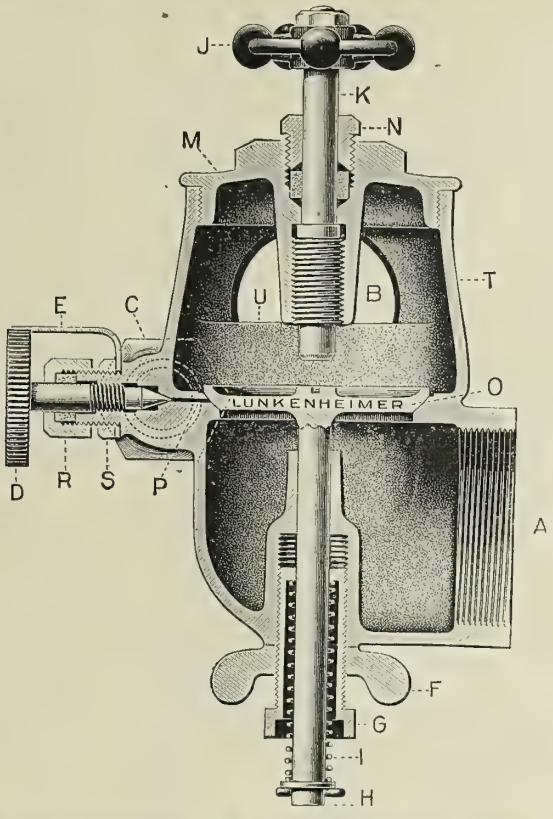


TESTING OF DIRECT-CONNECTED UNITS.

### An Improved Generator Valve.

An improved form of generator valve has lately been placed on the market by the Lunkenheimer Company, Cincinnati, which embodies a number of desirable and important features highly appreciated by users. The sectional view herewith clearly illustrates the construction of the valve. One of its principal features is the easy regulation of the spring which holds the disk to its seat. This regulation can be easily accomplished (while the engine is running), and without in any way interfering with the proper operation of the valve.

It has been found that gasoline engines work best with the generator valve-disk spring set at some particular tension; but as this particular tension cannot be ascertained except by trial, when the engine is in operation, it is necessary that provision be made

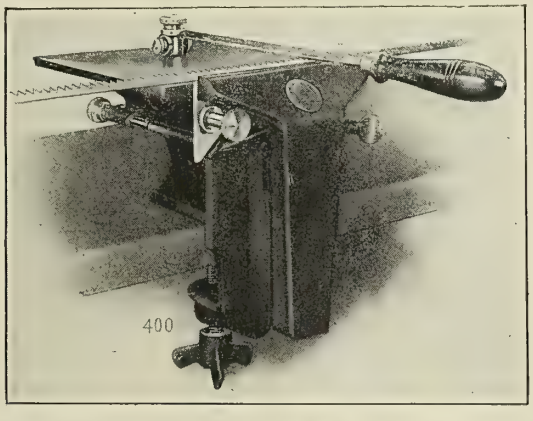



for the easy adjustment of the spring while the engine is running, which important feature will be found in this improved form of generator valve. The lift of the disk, and consequently the speed of the engine, is regulated by means of the stem *K* operated by wheel *J*.

The valves are made of a very high grade of bronze composition, and the metal is so distributed about the valve that those parts subjected to the greatest strain are made heavier in proportion. Owing to the oxydizing effect of gasoline on iron or steel, these materials are entirely eliminated.

### A New Band Saw Filer.

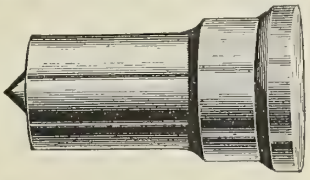
Joiners and boat builders will be interested in a new device just issued by the New Britain (Conn.) Machine Company (Dept. M), which is designed to obtain the best results in filing saws without any possibility of leaving a rough edge on the tooth. The work is done by hand, and the adjustment is such that a splendid job is possible. The outfit may be attached to any bench not over 2 inches in thickness, and weighs complete 14 pounds.




The file is guided mechanically in a horizontal direction, and also prevented from turning in the hand. These guided movements determine the contour of the tooth, remove any tendency to variations in the shape of same and limit the personal skill required.

### New Process Punches.

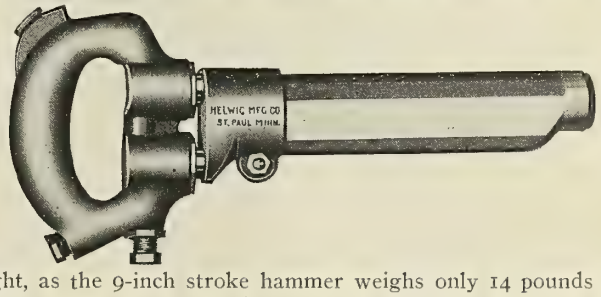
By the use of high grade steel especially adapted for punches, and an exact method of tempering, the George F. Marchant Company, of Lake and Elizabeth streets, Chicago, claim to make every punch absolutely uniform in quality. The punch illus-



trated has been made according to the above method, and it is claimed that a great gain is effected by their use because of their avoiding the loss of time required for changing defective punches in the presses.

### The Helwig Pneumatic Hammer.

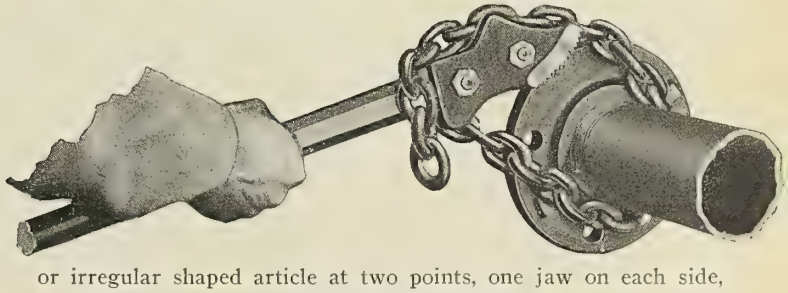
A good point about the hammers placed on the market by the Helwig Manufacturing Company at St. Paul, Minn., is that they are cushioned in the handle, thus conducing to ease of operation with absence of jar. They are very powerful for their



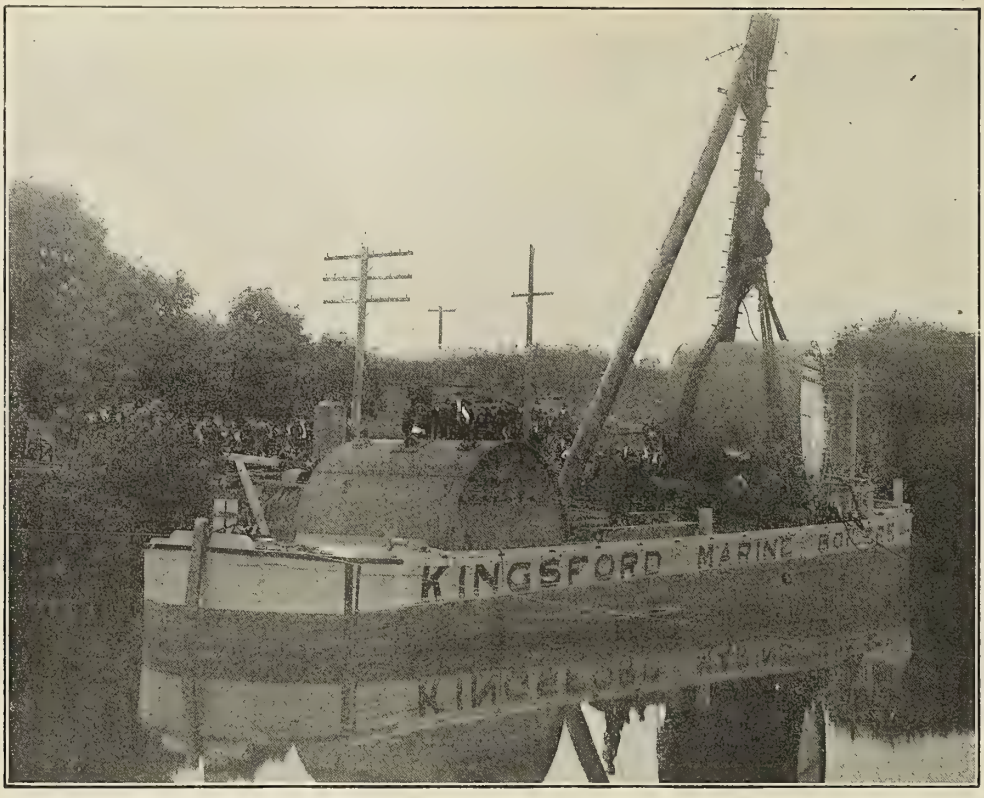

weight, as the 9-inch stroke hammer weighs only 14 pounds and handles rivets up to 1¼ inches. The chipping hammers may be used within three-fourths of an inch of the corner of a wall. The valve is made of solid steel, working in a phosphor bronze cushion, which is replaceable. The throttle valve, barrel and piston are also of steel. The throttle is very sensitive and easy of operation.

### The Ideal Chain Wrench.

The Ideal wrench, placed upon the market by Kroeschell Bros. Co., Chicago, presents a radical departure from all the existing types. It has a double biting surface in either of its jaws: the outer one has flat serrated edges, which will grip the pipe securely, the same as ordinary chain wrenches, and which are so arranged that the gripped article cannot be crushed; the inner biting surface has jaws of the shape of a wide V, which are especially designed to grip beaded fittings or valves, flanges and castings of odd form. These V-shaped jaws take hold of the beaded fitting



or irregular shaped article at two points, one jaw on each side, and this assures an absolutely firm grip, just the same as the grip on pipe or on a flat surface. The automatic chain lock consists of an incline or slide toward the lock. The operator, by simply pulling the chain, causes it to drop into the lock, with all slack taken up. The chain, while locked, is held with absolute security, even if used in an inverted position. Another advantage is the ease with which a break in the chain is remedied. Such breaks arise generally from the chain wearing on the pipe, hence occur at a short distance from the jaws.

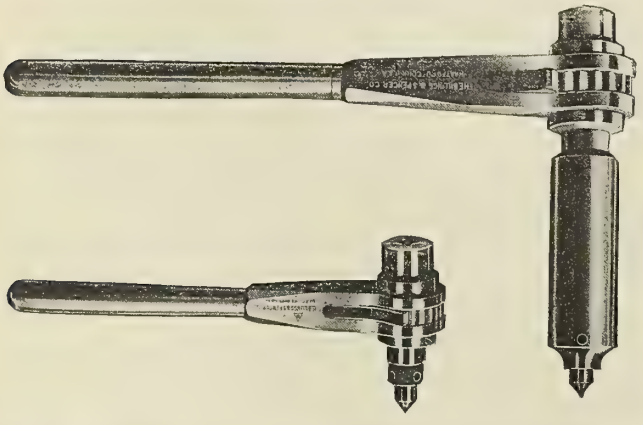



### Marine Boilers Shipped by Canal Boat.

The illustration shows two large marine boilers, built by the Kingsford Foundry and Machine Company, of Oswego, N. Y., and shipped to New York for use in a sea-going vessel by means of the Oswego and Erie canals. The boilers are of the regular Scotch cylindrical return tubular type, being single-ended and fitted each with four furnaces. The mean diameter is 14 feet 6 inches and the length, which is 12 feet 6 inches, is in one piece, making the courses of the boiler each 12 feet 6 inches long. The furnaces are of a standard corrugated type, 38 inches in mean diameter. There are three hundred and eighteen tubes 3 inches in diameter and 8 feet 10 inches long. Each boiler weighs 55 tons.

### New Ratchet Drill.

The device which we illustrate is being manufactured by the Billings & Spencer Company, of Hartford, Conn., in four styles, known respectively as the genuine packer, the boiler, the railroad, and the Billings double-acting ratchet. The latter can be changed



from a right-hand to a left-hand ratchet by moving a pawl. The boiler ratchet has been especially designed for use in awkward corners of boilers. All these ratchets are drop forged of steel, and all working parts are hardened and polished. They can be furnished in several sizes.

### Bilge Siphon Shoes for High-Speed Vessels.

*Editor* Marine Engineering:

From the frail structure and economic equipment of light-draft, high-speed steam vessels, such as are employed in this and foreign countries for scouts, destroyers, and torpedo boats, the writer is of the opinion that these frail craft in the presence of an enemy can soon be put *hors de combat* by a few well-directed shots from rapid-fire guns. As weight is quite a factor in their construction and equipment, considerable sacrifices are made for speed, and their complement of auxiliaries is reduced to the minimum, with manifold duties to perform. The appliances for ejecting water from their bilges are limited to one or two light service steam pumps of small capacity, several steam siphons, and occasionally a bilge injection, which are sufficient for ordinary cruising purposes, barring accidents. In the time of great need, however, as in the presence of an opposing fleet, should their hull receive punctures from projectiles, at or below their water-line, they will soon fill and turn turtle, and a pawn in the game of war is lost at a critical moment.

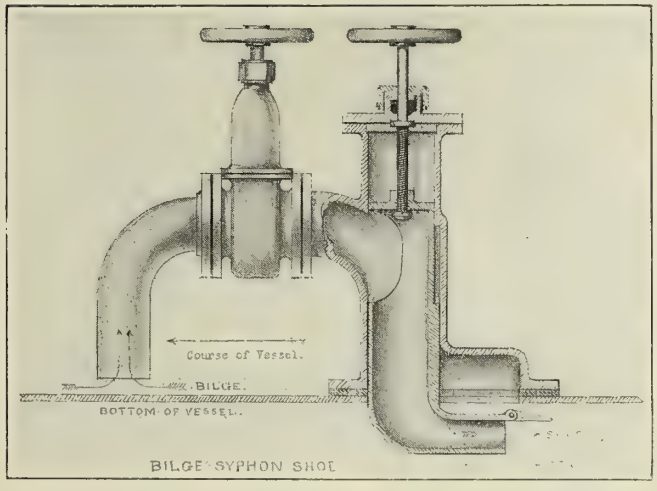
To increase the efficiency of this arm, so that it may be possible for them to reach their goal and create confusion to the enemy, the writer suggests the equipment of these vessels with a series of siphon shoes, of the description presented in the accompanying sketch. By the installation of this device in the several amidship compartments, these vessels will be more able to approach an enemy and inflict fatal injuries to hulls, and should they receive in return what was previously termed serious punctures, they can speed away to a harbor of safety, or make temporary repairs in transit, and again become a factor.

This bilge siphon consists of a cylindrical composition case expanded at the lower end to form a housing for the shoe. Its side is pierced with a curved nozzle having a flange for the reception of a gate valve. This gate valve has a copper bilge connection with easy radii, and is tinned inside and out to prevent galvanic action. The ends of the case are flanged to receive a bonnet and for securing to a reinforce plate attached to hull. Enclosed in this case is another cylinder having its lower end bent at an angle of 90 degrees, or parallel to the water-line of vessel, which forms the suction shoe in this device. The bottom of this shoe is flattened to conform to the shape of hull, so that when housed within

the case there is no obstruction to catch seaweed or floating *débris,* or to retard the progress of the vessel.

To illustrate the advantages of this device to vessels of the character under consideration, let us assume that they are equipped with it, and that they have received, in an attack, serious injury from projectiles piercing the hull below water-line, and that more water is entering these fractures than the steam appliances can eject. By speeding away from the zone of fire and projecting the suction shoe into the sea, and opening the gate valve on bilge connection, the bilge water will be drawn into the sea in such quantities as the area of shoe will permit. The sea in rushing past the mouth of these shoes creates a partial vacuum, sufficient to overcome the pressure of shallow depths, and with the assistance of the atmospheric pressure upon the bilge water it will be forced over the loop into this void, and when the circuit is established the water will continue to flow through these shoes into the sea as long as there is water in the compartment, and the vessel is moving swiftly through the sea.

For precautionary measures, these shoes can be projected into the sea as soon as the vessel arrives within the range of fire, as



BILGE SYPHON SHOE

their mouths are protected by swinging checks, which will prevent the sea water from entering the hull during the excitement of backing and filling in maneuvering the vessel to safety. Again, to more fully demonstrate the advantages of these suction shoes, let us assume that a vessel has insufficient means for ejecting water from the hull, and it is desired to install suitable appliances to remedy this defect, being compelled from the character of the vessel to take into consideration the factor of weight. As light service steam pumps are generally employed for this purpose, we will compare their weight and efficiency to that of a bilge siphon shoe. A steam pump capable of ejecting a 4-inch stream of water from the bilge of a vessel, will weigh approximately, with its manifold connections, 1,800 pounds. A bilge siphon shoe and its connections, capable of performing the same amount of work, will weigh about 300 pounds, which gives a difference of 1,500 pounds between the two methods for removing the same amount of bilge water, without using steam from the generators, which can be advantageously employed at these critical periods in driving the main engines.

From the above deductions, one steam pump will weigh six times as much as one bilge siphon, or, the pump will weigh as much as six siphons, which are capable of removing from the hull six times as much water as one pump, when the vessel is moving rapidly through the sea. The writer does not wish it to be understood from the above remarks that he advocates the removal or entirely doing away with steam pumps for removal of bilge water; he merely wishes to demonstrate that these bilge siphons are an economic equipment for light-draft, high-speed vessels for the removal of water from hull in an emergency, in comparison to the weight and efficiency of a series of steam pumps to perform the same service under like conditions.

As economy of space in vessels of this type requires the installation of their auxiliaries in congested places, these siphons can be fitted to skin of vessel under the floor plates, with the wheels for operating the shoe and valve protruding. By having non-rising stems to valve and shoe, it is possible to operate these siphons from the deck by gearing the wheels and extending a stem up through a deck plate.

George C. Stanley.

## TECHNICAL PUBLICATIONS.

**Transactions of the Institution of Naval Architects.** Volume XLVII., 1905. Published in two parts in separate volumes. Size, 8½ by 11 inches. Pages, 433. Plates, 88.

The scope of this work can be best indicated by listing the papers included in the text. It will be noted that in each case the papers were followed by discussions by competent naval architects, and that in many cases the discussions, in the variety of information brought out, are of even more value than the papers. The list is as follows:

PART I.

Design of the Antarctic Exploration Vessel *Discovery.*

Armored Cruisers *Kasuga* and *Nisshin* of the Imperial Japanese Navy.

The Russian Volunteer Fleet.

The Strength of Ships, with Special Reference to Experiments and Calculations Made Upon H.M.S. *Wolf.*

The Influence of the Proportions and Form of Ships upon their Longitudinal Bending Moments Among Waves.

Some Experiments on Structural Arrangements in Ships.

Model Experiments on Hollow *versus* Straight Lines in Still Water and Among Artificial Waves.

The Effect of Acceleration on Ship Resistance.

The Effect of Motion Ahead on the Rolling of Ships.

Some Results of Model Experiments in Deep and in Shallow Water.

PART II.

Margins and Factors of Safety, and their Influence on Marine Designs.

Notes on the Variation of Angular Velocity in the Shafting of Marine Engines.

A Method of Preventing Vibration in Certain Classes of Steamships.

The Admiralty Course of Study for the Training of Naval Architects.

Submarine Signalling by Means of Sound.

Naval Strategy and Tactics at the Time of Trafalgar.

The Ships of the Royal Navy as they Existed at the Time of Trafalgar.

Classification of Merchant Shipping (Illustrated by a Short History of Lloyd's Register).

Experiments with Models of Constant Length and Form of Cross Sections, but with Varying Breadths and Drafts.

Experiments on the Effect of Depth of Water on Speed, Having Special Reference to Destroyers Recently Built.

Deductions from Recent and Former Experiments on the Influence of the Depth of Water on Speed.

Fractures in Large Steel Boiler Plates.

A Comparison of the Performances of Turbines and Reciprocating Engines in the Midland Railway Company's Steamers.

Notes on the Causes of Accidents to Submarine Boats and their Salvage.

**Faulty Diction; or Errors in the Use of the English Language and How to Correct Them.** By Thomas H. Russell. Pages, 149. Size, 2½ by 5½ inches. George W. Ogilvie & Company, Chicago. Price, cloth, 25 cents; flexible leather, 50 cents.

This little pocketbook gives a considerable amount of information regarding the pronounciation and proper use of words

which are continually mispronounced or misused in ordinary speaking and writing, and would be of great value to anyone whose work requires very much of either.

**The Mechanical World Pocket Diary and Year Book for 1906.** Nineteenth annual issue. Size 4 by 6¼ inches. Pages 391; figures 73. Manchester: Emmott & Company, Ltd. Price 6d. net.

Within a small compass, in a book conveniently carried in the pocket, have been collected a large number of tables of engineering data of all descriptions, from the usual mathematical and trigonometrical tables to horsepower, steam, and vacuum tables, tables of the properties of I- and Z-bars, shafting and the strength of materials, electrical constants and wiring tables, hydraulic data, tables of bolts, nuts, and threads, conversion tables between metric measures and the corresponding British units—in short, all of the usual data and tables to be found in the general engineering reference books. In addition to this are to be found many "chapters" or notes on various subjects of an engineering character, such as engines, boilers, valve setting, pumps, oil and gas engines, belt and rope driving, electric machinery, power transmission and devices, and a multitude of other items of interest to the engineer.

In the rear of the book are a diary and blank pages for memoranda. A splendid and very complete index renders the book exceedingly easy of access, and adds enormously to its value as a work of ready reference.

**Steam Power Plant Data Book.** By Charles E. Lucke, Ph.D. Size 8 by 13 inches. 75 double pages. New York: D. Van Nostrand Company, 1905. Price $1.50.

This book is intended for use in connection with a very complete test of a steam-power plant or for recording results of a professional inspection of such a plant. It takes up in great detail the matter of the various items entering into a plant, with spaces on the left-hand pages for sketches and on the right-hand pages of corresponding number for compilation of the data involved in the test or acquired at the inspection. Something of the completeness of the work may be evidenced by noting the fact that it goes into such subjects as ash handling, coal handling, flues, chimneys, fan blowers, boiler feed, piping, feed-water heating and economizers, condenser systems, water purification, lubricators, heating, ventilating, and elevator systems of buildings, etc. For the purpose for which it was designed it appears to be exceptionally complete.

**The Story of Noah's Ark.** By E. Boyd Smith. Size 8½ by 11 inches. Pages 56. Boston: Houghton, Mifflin & Company, 1905. Price $2.00 net.

This is a Christmas book containing twenty-six full-page illustrations in colors with pictorial title page and cover. It depicts the story of Noah and the ark from the time when the first warning was sounded until the ark had come to land, and its crew and passengers had again found footing on the earth. The illustrations, showing a great variety of animals pair by pair, are splendidly drawn and gorgeously colored, and many amusing situations are described and illustrated. The text accompanying the illustrations is very brief and has a dry and solemn tone well in keeping with the gravity of the subject, but is written in such a manner as to increase the humor of the entire production. The book is bound to be popular with all who see it.

**Practical Planer Kinks for Planer Hands.** By Carroll Ashley. Size 4¾ by 7½. Pages 80; figures 32. New York: Hill Publishing Company, 1905. Price $1.00.

This little book is stated in the preface to have been written for the planer hand by a planer hand, and covers a large scope of practical subjects connected with the use of the planer, and the various attachments which go with it. The writer brings to his task the value of the experience obtained during a seven years' apprenticeship on the planer, and gives a great many pointers which ought to be of much value to those interested. Most of the illustrations have already appeared in *American Machinist*, and are well adapted to bring out the points made by the author.

**The Panama Canal:** System and Projects of Lindon W. Bates. Size, 8½ by 11 inches. Pages, 180; plates, 15. Published by the author, New York, 1905.

The projects, briefly described in Marine Engineering for June, 1905, are here given a very comprehensive description, and a large amount of data and information referring to the geologic and climatic conditions on the Isthmus of Panama is collected into the volume, which is thoroughly illustrated with half tones and diagrams in addition to the plates above mentioned. The entire proposition is carefully covered as a result of personal inspection of conditions on the Isthmus, and the two projects which Mr. Bates has placed before the Commission, together with a third or supplementary project, are given full description. The arguments presented seem to show that they cover the ground much more thoroughly and satisfactorily than any other scheme presented up to date. It might be mentioned that one of the strong points brought out is concerned with the sanitary proposition, which other projects have very largely ignored. The scheme of terminal lakes advocated by Mr. Bates not only conduces to ease and cheapness of construction, but obliterates entirely the swamps now existing at the two ends, and well known to be beautiful breeding grounds for the fever-bearing mosquito. The fifteen plates mentioned cover relief maps of both of Mr. Bates' projects, plans of dams, dykes and locks of various projects, harbor plans, comparative excavation profiles and diagrams dealing with not only the engineering but the financial end of the proposition.

**Bureau Veritas:** General List of Merchant Shipping of All Nations. Size 7 by 10 inches. Two volumes, price £3 3s. Volume I, Steamers, pages 1,563; price £1 15s. Volume II, Sailing Vessels, pages 1,230; price £1 10s. Bureau Veritas, 8 Place de la Bourse, Paris; 155 Fenchurch street, London, E. C.; 17 State street, New York. 1905.

These books give lists of all the steamers and sailing vessels in the world, with information covering such items as tonnage, date of construction, material of construction, draft of water, etc., for sailing vessels, and the same for steamers with additional figures covering machinery, etc. There are also tables acting as a sort of cross index, giving the various companies and other owners operating these ships, so that any ship may be located from either the point of view of its name or that of owner.

## QUERIES AND ANSWERS.

All reasonable questions concerning marine engineering received from and signed by subscribers will be answered by the Editor in this column. All communications must bear the name and address of the writer.

Q. 307.—Please answer the following in your next issue:

(*a*) What formula will give weight of flywheel rim suitable for gasoline marine engines of following types?

1 single-cylinder, two-cycle.
2 " " " "
3 " " four-cycle.

(*b*) On page 173 of your April issue for 1905, giving an account of the auto-boat *Hilda*, appears the following formula:

$$M = \sqrt[3]{\frac{B^2 V^3}{F}} = \sqrt[3]{\frac{0.27 \times (17.11)^3}{45}} = 3.11.$$

What do $M$ and $B$ represent, and how is the formula applied?

The Admiralty constant for the *Hilda* $= \dfrac{D^{\frac{2}{3}} \times V^3}{I.H.P.} = 150.2$, a fine performance for her size.

(*c*) What weight, at a radius of 12 inches, will twist off a Tobin bronze shaft 1 inch in diameter and 12 inches length, subjected to torsion?

(*d*) Have any experiments been made to determine the tow-rope resistance of launches of 40-foot length and under, similar to those made by Froude on the *Greyhound*? Or the actual thrust as described in your issue of August, 1903, page 414, in the case of the tug *Vlaardingen*?

E. F. K.

A.—(*a*) For the weight of a fly-wheel rim the formula used is $W = \dfrac{\Delta E g}{V^2 K}$, where $W$ is weight in pounds, $\Delta E$ is the difference

between the average crank effort of the engine and the maximum crank effort (or minimum, whichever may give the greater difference), $g$ is the acceleration due to gravity (= 32.2 feet per square second), $V$ is the mean velocity of the rim in feet per second, and $K$ is the maximum change of velocity in the rim during one revolution, divided by the mean velocity. This formula, which is a perfectly rational one, is derived from the consideration of the effect which the inertia of the rim will have in steadying the rate of revolution, and is applicable to the case of any engine which may be under consideration, provided we have data sufficient to enable us to determine the amount of energy produced by the explosions of the gasoline and the expansion during the different operations of the stroke.

(*b*) The formula given on page 173 of our issue for April, $M = \sqrt[3]{\frac{B^2 V^3}{F}}$, is one relating a propulsive coefficient of the vessel to its block coefficient. It is in all respects similar to the Admiralty coefficient quoted by our correspondent, and serves simply as a means of comparison between performances of different vessels. The $M$ is the coefficient in question, $B$ is the block coefficient, which in this case was 0.51, $V$ is the speed in knots, and $F$ is the horsepower.

(*c*) The formula for relating the resilience of a shaft to the effort to disrupt it by torsion is $Pa = \frac{\pi\theta G d^4}{32l}$ where $P$ is the force operating at a distance $a$ from the axis of the shaft, $\pi \frac{d^4}{32}$ is the polar moment of inertia of the section of the shaft, $G$ is the modulus of elasticity of the material, $l$ is the distance between the point of application of the twisting force and the point of support of the shaft, and $\theta$ is the angle through which the outer end of the shaft turns during the process. Without special knowledge on the properties of Tobin bronze, it would be impossible to give a quantitative answer to the question asked, but the general method of analysis is that shown by the formula.

(*d*) Experiments were conducted in England last spring on full-sized models of gasoline launches from 25 to 40 feet in length, by towing them from a spar rigged out from the deck of a torpedo-boat destroyer, and very valuable results obtained. Particulars of these tests, with numerous photographs, were published by *Engineering*, of London, soon after the tests were made.

Q. 308.—Kindly answer the following relative to the screw propeller:
(*a*) What is the difference between real or positive and apparent slip?
(*b*) What is the difference between the developed and the projected surface of a propeller?
(*c*) What is the disk area?
(*d*) What is the surface ratio? G. J. L.

A.—(*a*) A propeller acting to drive a moving ship is operating in water disturbed by the passage of the ship through it. That is, water follows to a certain extent the motion of the ship, and this extent is greater the nearer the particle of water is to the side of the ship. It results that the propeller is acting in water moving in the direction of the motion of the ship. If, therefore, we calculate the slip of the propeller as based upon the water in which it is actually moving, the resultant figure will be greater than if we calculate the slip basing it upon a stationary point or upon the water at some distance from the ship. In other words, the apparent slip, which is calculated from still-water conditions, is the difference between the pitch of the propeller multiplied by the number of revolutions, and the amount of advance of the propeller and ship during the period of time for which the revolutions are counted. On the other hand, the true slip is the difference between the product of the pitch of the propeller and the number of revolutions in a given time, and the motion of the propeller and ship with relation to the moving water in which the propeller acts.

(*b*) The developed area of a propeller blade is the actual total area of the blade; while the projected area is that portion of the area which would be seen by an observer stationed somewhere in the line of the propeller shaft but at a considerable distance from the propeller. The projected area is less than the developed because from the position at which the area is seen by the observer the actual or developed area of the propeller is viewed at an angle, and its dimensions proportionately foreshortened.

(*c*) The disk area is the area of the circle swept by the tips of the blades; in other words, it is the area of a circle whose diameter is equal to the diameter of the propeller.

(*d*) The surface ratio is the ratio between the developed area of the propeller and the disk area.

Q. 309.—Kindly give in the column of Queries and Answers some formula for figuring the size of expansion bends in steam pipes necessary for a given length of pipe and a given change in temperature. If any treatise on this subject is in print you would oblige by mentioning same. A. G. C.

A.—We know of no formula for figuring the radius of expansion bends in steam pipes except in the one case where the bend is a complete loop, in which case Bauer & Robertson give a formula $A = 2\sqrt{D \times L}$, where $A$ is the vertical height of the coil, $D$ is the external diameter of the pipe, and $L$ is the distance between the two closed ends of the coil, all measured in inches.

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**Civil service examinations** for mechanical draftsmen for work on the Panama Canal will be held December 6 at the usual places throughout the United States, and applicants should apply to the United States Civil Service Commission for form 1312. The subjects of examination include mathematics and practical calculations, drawing, materials of construction, and a statement of training and experience. The salaries range from $1,200 to $1,800.

Examination is announced for December 6 and 7 to fill two vacancies for fourth assistant examiner in the patent office at $1,200 per annum, the subjects covering physics, chemistry, mathematics, technics, mechanical drawing and French or German. Applicants should apply for form No. 1312.

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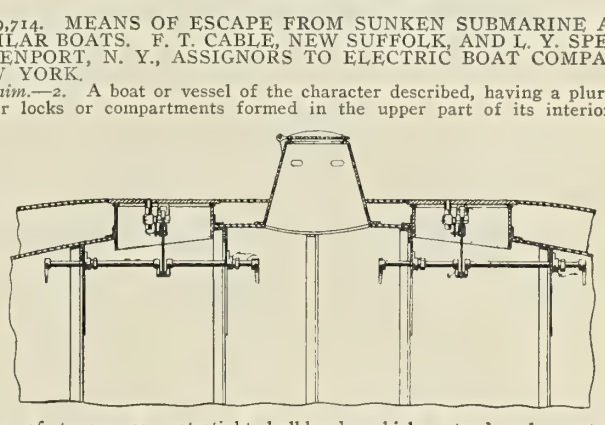
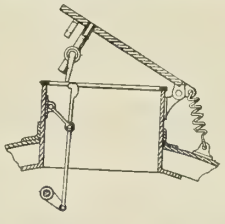
## SELECTED MARINE PATENTS.

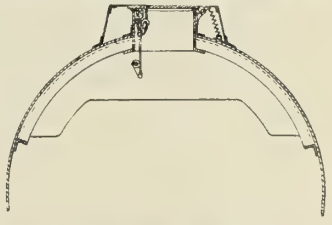
799,714. MEANS OF ESCAPE FROM SUNKEN SUBMARINE AND SIMILAR BOATS. F. T. CABLE, NEW SUFFOLK, AND L. Y. SPEAR, GREENPORT, N. Y., ASSIGNORS TO ELECTRIC BOAT COMPANY, NEW YORK.

*Claim.*—2. A boat or vessel of the character described, having a plurality of air locks or compartments formed in the upper part of its interior by



means of transverse watertight bulkheads which extend only part way down through the depth of the boat, hatches in the hull opening one into each of said compartments and provided with a cover or scuttle, means for

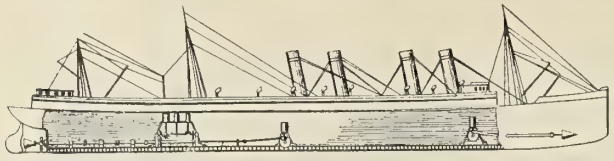




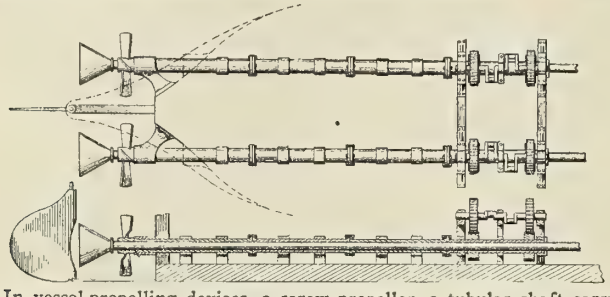
securing said covers and for releasing them independently from one of the adjacent air locks, and means also for controlling the escape of air from such air locks and operatable from adjacent air locks. Five claims.

800,481. BOAT PROPELLER. MIGUEL PEREZ, ST. LOUIS.

*Claim.*—1. In vessel-propelling devices, a pair of tubes arranged one on each side of the bow of the vessel and extending through the hull in a line



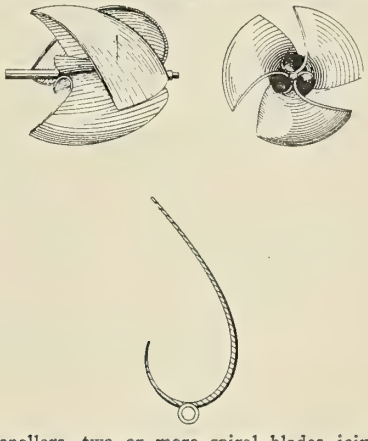
parallel with the longitudinal plane of the keel, a second pair of tubes arranged at the stern of the vessel and projecting through the hull, also on lines parallel with the plane of the keel, rods extending through the tubes, conical propellers at the outer ends of the rods, and independent driving means for the pairs of rods at the bow and stern, said propelling means being arranged to move the forward propellers in one direction, while the aft propellers are simultaneously moved in the opposite direction.



2. In vessel-propelling devices, a screw propeller, a tubular shaft carrying the same, means for revolving the shaft, a reciprocatory rod extending through the shaft, and a conical propeller secured to the rod to the rear of the screw propeller. Three claims.

799,800. SCREW PROPELLER. FRANK A. NEWELL, FALLAN, MONT.

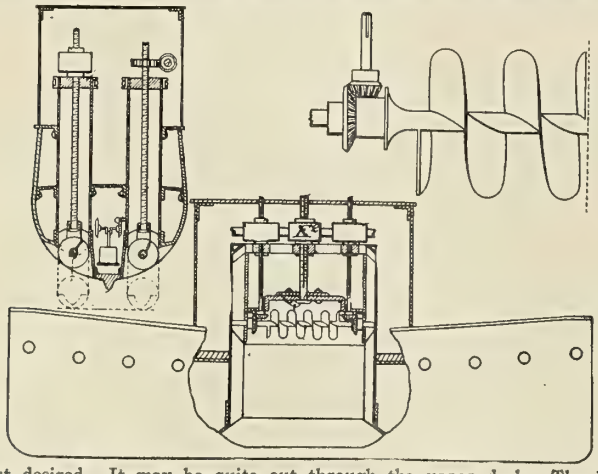
*Claim.*—1. In screw propellers, two or more spiral blades joined together with a rotary shaft, each blade being scoop-shaped and provided with a hook-shaped free extension beyond the joint with the shaft.



2. In screw propellers, two or more spiral blades joined together on a rotary axis and each blade provided with a hook-shaped free extension beyond the axis. Two claims.

800,184. PROPELLING VESSELS. ROCCO STOLA, NEW YORK.

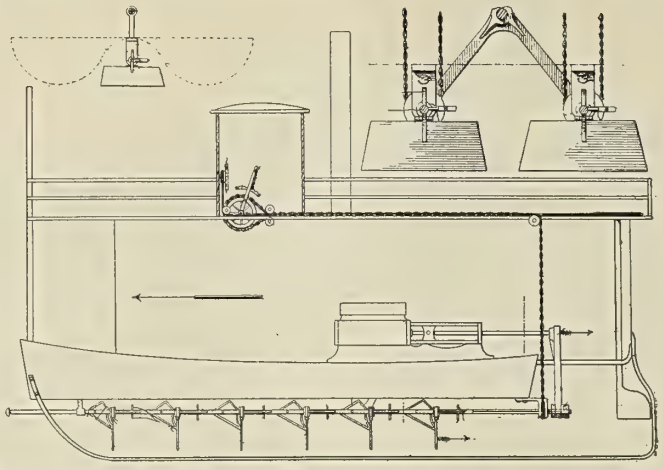
*Abstract.*—Two screw propellers are provided at or near the mid-length of the vessel, with means for thrusting each downward into a position where it can act efficiently on the water when it is to be used. Each propeller is mounted in a well, extending from an opening in the bottom up to any



height desired. It may be quite out through the upper deck. The lower end of each well is flared at the front and rear, so that the water finds ready access at the front and also ready discharge at the rear even when the propeller is drawn up so as to be entirely protected within the general lines of the bottom. Six claims.

801,560. BOAT-PROPELLING MECHANISM. HOWARD Y. THOMAS, CHARLEROI, PA.

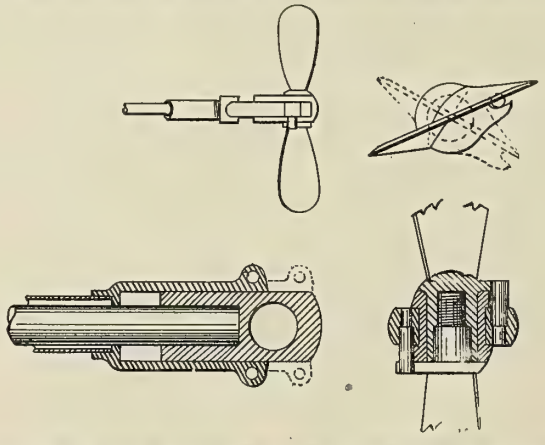
*Claim.*—9. A propeller-shaft mounted for reciprocation and oscillation, paddle-carrying members mounted for rotation upon said shaft, paddles hingedly connected with said members, paddle-engaging lugs radiating from



the shaft, disposed respectively in front and in rear of the paddles at approximately right angles to one another and having paddle-engaging faces at approximately right angles to the axis of the shaft, auxiliary paddle-engaging lugs disposed in front of the paddles diametrically opposite to the above-mentioned lugs in front of the paddles, and having obliquely-disposed paddle-engaging faces, and means for rotating the shaft in its bearings and securing it at various adjustments. Fourteen claims.

801,684. PROPELLER-WHEEL. H. J. PERKINS, GRAND RAPIDS, MICH., ASSIGNOR OF ONE-THIRD TO F. L. PERKINS AND ONE-THIRD TO C. E. PERKINS, GRAND RAPIDS, MICH.

*Claim.*—2. The combination with a propeller-shaft, a hub rigidly secured thereto, blades provided with shanks at their inner terminals, one of said shanks having a receptive construction and passing entirely through the hub, the shank of the other blade being centrally journaled in the shank of the first-named blade and extending into the latter a depth equal to the diameter of the hub, and having a bearing solely within the shank of the



first-named blade, each blade also having a shoulder which fits closely against the hub, a yoke slidably mounted on the hub and shank, oppositely-extending pins rigidly secured in the yoke and arranged to engage portions of the propeller-blades, the latter having recessed flanges to receive pins, and means connected to the yoke for imparting longitudinal movement to the latter with respect to the hub to simultaneously change the angle of the blades. Two claims.

801,985. PACKING-EXPANDING DEVICE. EADS JOHNSON, BAYONNE, N. J., AND WILLIAM McDERMOTT, PORT RICHMOND, N. Y.

*Claim.*—1. In combination, a piston-follower; a piston end piece; a threaded member passing through said follower and rotatably mounted in said end piece; a spreader which is mounted free to travel along said threaded member when the latter is rotated; expandible devices actuated by the movement of said spreader; and means for securing said follower and end piece together.